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ABSTRACT

This training manual, the last volume in a four-volume series for use in training Peace Corps workers, deals with livestock. The first chapter provides suggested guidelines for setting up and carrying out the livestock component of the agricultural development worker training course. Included in the second chapter are lesson plans covering the following skill areas: livestock development, swine, rabbits, poultry, and goats. The third chapter consists of over 120 technical information sheets that can be duplicated and distributed to students. Appended to the manual are a bibliography, a list of supplies, small animal production training goals, and sample examinations. (MN)

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# AGRICULTURAL DEVELOPMENT WORKERS TRAINING MANUAL

## Volume IV Livestock

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THIS VOLUME IS ONE OF FOUR IN THE AGRICULTURAL DEVELOPMENT WORKER'S TRAINING MANUAL. EACH OF THE VOLUMES IN THE MANUAL AND A SUMMARY OF ITS TABLE OF CONTENTS IS PRESENTED BELOW:

VOLUME I: ORIENTATION FOR TRAINERS

Chapter 1: Orientation for Trainers

Chapter 2: Training Design

VOLUME II: EXTENSION SKILLS

Chapter 1: Orientation to the Extension Component of Agriculture Training

Chapter 2: Curriculum of the Extension Component

Chapter 3: Extension Resources (Handouts and Reprints)

VOLUME III: CROPS

Chapter 1: Orientation for the Crops Training Component

Chapter 2: Curriculum of the Crops Training Component

Chapter 3: Technical Guidelines and Reference for the Crops Training Component

VOLUME IV: LIVESTOCK

Chapter 1: Orientation for the Livestock Training Component

Chapter 2: Curriculum of the Livestock Training Component

Chapter 3: Technical Guidelines and Reference for the Livestock Training Component

# AGRICULTURAL DEVELOPMENT WORKERS TRAINING MANUAL

## U.S. PEACE CORPS Volume IV Livestock

**U.S. Peace Corps**

**Prepared by A. L. Nellum and Associates, Inc. under contract No. PC-282-1004**

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## PREFACE AND ACKNOWLEDGEMENTS

Volume IV of the Agricultural Development Worker's Training Manual has been developed for Peace Corps by A. L. Nellum and Associates, Inc. (ALNA) along with Volume I, II and III, at PENN Center in Frogmore, South Carolina in 1982.

The principal author of Volume IV is Neil Bacon, Senior Crops Livestock Trainer. Assisting him with the Poultry sections was Carmine Russo. Meg Brown and Michell Jacob also contributed ideas and resources to the product. Julia Simmons, Barbara White, Kim Thorne and Ronnie Gold prepared the text. Martin J. Blank supported the development of this volume in the ALNA headquarters office, while Michael Gibbons directed the overall project in Frogmore.

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We are also grateful to the following publishers for granting us the right to reprint selected tables and charts:

- Feeds & Nutrition - Complete by M.E. Ensminger & C.G. Olentine
  The Ensminger Publishing Co., 3699 E. Sierra Ave., Clovis, California 93612

- The Nutrient Requirements of Swine - 8th Edition, 1979
  The Nutrient Requirements of Rabbits - 2nd Edition, 1977
  The Nutrient Requirements of Poultry - 7th Edition, 1977
  The Nutrient Requirements of Goats - 1st Edition, 1981
  Office of Publications National Academy of Sciences
  2101 Constitution Ave., N.W., Washington, D.C. 20418

- Rabbit Production
  O.S.U. Rabbit Research Center
  University of Oregon, Corvallis, Oregon

- Small-Scale Pig Raising by Dirk Van Loon
  Garden Way Publishing, Charlotte, Vermont, 1978.

- Swine Science by M.E. Ensminger
  4th Edition
  Interstate Printers & Publishers, Danville, Illinois, 1970

The following additional resources were also particularly helpful in developing this document:

- A Veterinary Guide for Animal Owners by C.E. Spaulding D.V.M.
  Rodale Press, Inc., Emmaus, Pennsylvania 18049, 1976.

- Aids to Goatkeeping by Carol A. Leach
  8th Edition
  Tiger Press, Columbia, Missouri 65201, 1974

- Applied Animal Feeding & Nutrition by M.H. Jurgens
  Third Edition
  Kendall/Hunt Publishing Co., Dubuque, Iowa, 1974.

- Dairy Goats - Breeding/Feeding/Management
  American Dairy Goat Association, Box 186, Spindale, N.C. 28160

- Goat Disease Manual
  Winrock International, Petit Jean Mountain, Morrilton, Arkansas 72110

- Goat Production in the Tropics by Devendra & Burns
  Commonwealth Agricultural Bureaux, Farmham Royal, Bucks, England, 1970.

- Keeping Livestock Healthy - A Veterinary Guide by N. Bruce Haynes D.V.M.
  Garden Way Publishing, Charlotte, Vermont, 1978.

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  Second Edition
  M.L. Scott & Associates, Ithaca, New York, 1976.

- Poultry Production by Card & Nesheim
  11th Edition
  Lea & Febiger, Philadelphia, Pennsylvania, 1972.

- Poultry Science by M.E. Ensminger
  The Interstate Printers & Publishers, Danville, Illinois, 1980

- Raising Milk Goats - The Modern Way by Jerry Belanger
  Garden Way Publishing, Charlotte, Vermont, 1975.

- Raising Rabbits by Harlan D. Attfield
  Vita. Inc., 3706 Rhode Island Ave., Mt. Rainier, Maryland 20822, 1977.

- Salsbury Manual of Poultry Diseases
  Salsbury Laborotories, Charles City, Iowa 50616

- The Merck Manual of Veterinary Science
  Fifth Edition
  Merck & Co. Inc., Rahway, New Jersey, 1979.

- The Role of Sheep & Goats in Agricultural Development
  Winrock International Center, Morrilton, Arkansas, 1976.

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# INTRODUCTION TO VOLUME IV

## Purpose Of This Volume

This volume was designed to serve as a resource for livestock trainers. It was not intended to stand alone and should be used in conjunction with the other 3 volumes of this manual as well as the other technical publications listed in the bibliography. This volume provides ideas on how to integrate livestock training with other components into an Agricultural Extension training. For more detailed information on the use of these manuals refer to the Introduction of Volume I. This manual also provides technical guidelines to be used as resources.

This volume was written in conjunction with the other three (3) volumes that make up this manual. To run an integrated training they are to be used collectively. This volume is a resource for trainers rather than a blueprint of how to run a training.

## Intended Audience

This manual is intended for livestock trainers who are working in an integrated Agricultural Extension training program. It is designed primarily for experienced livestock trainers who are working with generalist Peace Corps Ag. volunteers.

## How To Use This Volume

Chapter I is intended to orient trainers using this volume to its contents. It also provides detailed ideas on how to prepare and carry out a livestock training.

Chapter II provides information on the curriculum. It includes a list of the five (5) different skill groups and a sessions list for each skill group. It also contains a lesson plan (grouped by their respective skill groups) for each session.

Chapter III includes the livestock technical guidelines and the appendix. Skill Group I (Livestock Development) is intended to be used in all trainings as a generic tool in learning about general livestock production. Skill Groups II through V are specific to four (4) different animals (swine, rabbits, poultry, & goats). These skills groups stand alone in the guidelines as separate sources of technical information. These guidelines can be adapted to different training situations where varying combinations of animals are used. For example, in one training rabbits and swine may be covered while in the next training it may be chickens and goats.

The guidelines represent a body of technical knowledge that can be duplicated and distributed to each trainee. Often trainers do not have time to draw up detailed handouts for each class. Therefore, these guidelines were written to fill the void of technical information. Hopefully, they will provide detailed, convenient, and easily accessible information to the trainee.

The Appendices include:

A. Bibliography and Resource Materails
B. Lists of Supplies
C. Small Animal Production Training Goals
D. Sample Examinations

# CHAPTER I: ORIENTATION TO THE LIVESTOCK COMPONENT OF AGRICULTURAL TRAINING

## A. OVERVIEW OF THE LIVESTOCK TRAINING COMPONENT

The technical content of livestock training has been organized into 5 skill groups in this manual. They are:

1. Livestock Development
2. Swine
3. Rabbits
4. Poultry
5. Goats

The technical training goals, the guidelines, and the curriculum (lesson plans) are all structured around these 5 skill groups.

Livestock training is designed to establish a basis for making the management decisions called for in the development of livestock operations. These are skills the volunteer will need if he or she is to work with small farmers. Because there are no absolutes in animal husbandry, our first goal is for the trainee to learn that in a complex system based on locally available resources there are very few instant technological innovations that are truly effective. For this reason the training is developed with a framework or continuum of development reaching from the high technical levels of production to the free range, survival level. Within this developmental continuum, training focuses on the five principal catagories of livestock development. They are:

1. Nutrition
2. Management
3. Diseases and Parasites
4. Genetics
5. Housing

Primary emphasis is placed on nutrition. This is the beginning and end of all livestock development. It has been simply stated that you cannot keep animals that you cannot feed. Furthermore, 75% to 90% of the cost of raising animals can be feed. The health of the herd and the profit or loss for the farmer are all directly controlled by the nutrition and feeding of the animals. Nutrition is the most limiting factor in livestock development and therefore is the area that volunteers must develop before changing breeding stock or management levels.

The training manual and guidelines take the approach that in order to develop a profitable livestock operation all five of the categories must be balanced on the same level of the continuum. This balancing point on the developmental continuum is determined by a host of factors including:

.Markets
.Pricing of feeds and meat
.Local infrastructure
.Water quality
.Cultural tastes in meat
.Credit

.Agricultural extension
.Government policies
.Management levels
.Diseases
.Vaccines
.Antibiotics
.Parasites
.Locally grown small feeds

Therefore, when trainees learn the mechanics of a given technique (such as wing clipping), they also must consider the context in which the practice will be employed. To determine the appropriateness of a given practice or technique, trainees should constantly ask:

- Is this practice consistent with local management levels and resources?
- What are the potential risks for the farmer?
- Will it increase profit?
- Are the risks for potential loss too great to justify the potential gain?
- What short and long term effects will it have on the livestock operation?

The training manual/guidelines provide an integrated approach to technical information and ability as well as agriculture extension worker skills. The lesson plans reflect integration of these skills through an experiential training methodology implemented through intensive "hands-on" learning. 60% of the technical training time is spent working with the animals and 40% in the classroom. The trainees are responsible for the daily feeding, watering, and caring for the animals. Training is done primarily through readings and dialogue - not through lecture.

## B. PREPARING THE LIVESTOCK COMPONENT OF AGRICULTURAL TRAINING

### 1. TASK LIST

You should complete the following tasks and get answers to these questions before training starts.

a. Order the books listed in the bibliography 2 or 3 weeks before training starts. *They will be needed for training*. The bibliography list is in the appendix.

b. Purchase and borrow (if possible) the animals to be used during training and have them housed near your classroom.

c. Arrange for credit at the local feedstore or mill and have an adequate supply of animal feed on hand to start training.

d. Either scrounge or buy the materials listed on the Livestock Supply List that are needed for your training. The supply list is in the appendix.

e. Visit the local extension office and get to know the Ag. Extension agent who works in your area. He or she can be invaluable in assisting you with the farm visits and with information about the community.

f. Work with the local extension agent to meet some of the local farmers who are working with the same animals used in training (and at a similar level of production). Arrange for farm visits to their farms. Make sure that the visit will give the trainee the chance to work with some of the skills that he or she has gained--both technical and Ag Extension skills. The farm visit should be an opportunity to use observational as well as practical skills.

g. Ensure that transportation will be available when you need it.

h. Have all reference materials and guidelines printed and ready to be given to the trainees by the first day of training.

i. Review the lesson plans contained in Chapter II and adapt them to the conditions of your training program. They are the key to a smoothly run training.

j. Know, *exactly*, how much money you have in your budget so that you can plan for all needed materials without overspending.

k. Know how many trainees will be arriving. Read over their Pre-Training Questionaires in order to become familiar with their backgrounds.

l. Study the TAC sheets for their program.

m. Gather as much information as possible on specific host country conditions concerning diseases, parasites, nutrition, climate, management practices, and local infrastructure.

n. Become acquainted with the other staff members and build a team that is responsive to training demands.

o. Do you have classroom space reserved for all of your sessions?

p. Do you have enough animals on hand for the field sessions? Will all the trainees be able to participate?

q. Spend time sharing your work plans with the rest of the staff (crops, administration, extension).

r. Have your training schedule complete for the entire training.

s. Delegate work to the other livestock trainers and training assistants. Decide on responsibilities within the livestock component. Make sure that your staff is clear about their own roles and responsibilities. Do not allow the gopher work to drive you crazy.

t. Decide which staff member will be responsible for each session in the schedule so that they can begin to prepare early.

## 2. SITE PREPARATION

As much as is possible try to have all the animals housed in a central location. This will save class time later since the trainees will have less distance to walk. Try and replicate the conditions that animals are typically raised under in-country. Do not spend a lot of money on housing and equipment. Use what is available locally at little or no cost. You should, as a matter of practicality and as an example to the trainees, scrounge and recycle as much as possible. The convenience and expediency that training often demands should be balanced with practicality and appropriateness (compared to in-country situations) that make training realistic.

## 3. PREPARING THE LIVESTOCK STAFF

The issues of staff training and team building were addressed in Volume I. However, within the livestock component there will be decisions to be made concerning training styles, work loads, and responsibilities. The questions below should help in making these decisions.

- How many livestock trainers are on the staff?
- Which animals will be covered in the training?
- How many hours does the livestock component have?
- Which livestock trainer will take responsibility for which classes?
- Will one trainer be responsible for one animal only?

- Which trainers are qualified to train on more than one animal?
- Will classes be taught individually or will you team teach?
- If you train as a team in a given session, then who will take the lead and assume primary responsibility?
- During field sessions what ratio do you wish to maintain (number of trainees to trainer)?
- How will changes in the schedule and other decisions be made within the livestock component? By the coordinator? Informally? In weekly staff meetings? By consensus?
- Will the coordinator be responsible for the livestock component budget?

The answers to these questions should provide the information needed to make decisions about how the livestock training is to be run. The combination of a staffs' technical skill and training skills needs to be examined closely in making decisions concerning these issues.

## 4. PRE-TRAINING RESEARCH

The important point here is to gather as much relevant information as possible about both the country in which the trainees will serve, the agricultural environment of the country, and the requirements and focus of the program. One source of information is the pretraining research trip which is discussed in Volume 1. Additional sources of information might be country staff (send cables before training), RPCV training assistants from the country, the desk officer, TAC sheets, and other staff. Specific information about livestock production in country is essential to the decision about which animals to cover during training. The farmer livestock survey included in the technical guidelines details the type of information needed.

## 5. CURRICULUM DESIGN

The 5 skill groups and the list of sessions included in Chapter 2 will assist the livestock staff in designing their curriculum. The design as presented in chapter 2 is only a resource and not a blueprint of a training that can be repeated without variation. It is important to adapt the curriculum into each new training design. The order and content of the classes will vary depending on the training site, climate, and the environment of the host country. Do not allow a rigid schedule to so restrict training that you are not able to take advantage of training options and opportunities as they arise. Listed below are some of the variables you will need to consider in designing the curriculum.

- Number of hours for livestock training
- Number of trainees

- Number of skills of the staff
- Host country information
- Emphasis of the program
- Which training goals and sessions are appropriate?
- Management levels of farmers in country
- Which animals are covered in the training and how many of them do you have for the trainees to work with?
- How many money do you have in your budget?
- How much space do you have for housing the animals?

## 6. THE LIVESTOCK SCHEDULE

Information that affects the livestock portion of the schedule will be discussed here. For more information on the scheduling process refer to Volume I. Once the livestock staff has agreed on which sessions are to be taught and their prospective order during training then entire staff (Crops, Language, Extension, and Administrative) can meet to draw up the final schedule. Listed below are some chronological steps to be completed in preparing a schedule.

a. Determine which animals will be covered during training and which will be excluded of the 4 covered in this manual.

b. Meet with the other trainers (language, crops, extension, and administration) to determine exactly how many hours livestock will have.

c. Set aside the times in the training that will not be available for sessions (meals, shots, etc.) Also establish the general time parameters of the training.

d. Decide how much time is to be used for each animal. If you are to cover swine, poultry, and rabbits during the training, do you divide the time equally between them or does one require additional time?

e. Examine areas of individual staff expertise. How many trainers are there? Which trainer will work with which animal? Will there be areas where the staff overlaps or team teaches? Assign primary responsibility for each of the livestock development sessions to one trainer who will then take the lead in that session.

f. Draw up a list of the sessions to be taught for each animal and decide how much time each session will take.

g. Divide the total number of hours for livestock by the number of weeks during training. Try to maintain that average number of hours each week.

h. Meet again with the rest of the staff to draw up the schedule.

When working through the above scheduling process consider the following points:

a. Maintain at least a 60/40% ratio between field and class sessions.

b. Remember that trainees will need time to feed and water the animals.

c. Try to schedule your classroom sessions first thing in the morning; avoid the last 2 hours of the day.

d. Try to maintain this general sequence:

-Overviews
-Construction
-Nutrition and feeds
-Diseases and parasites
-Management
-Genetics (breeds and reproduction)

However, take full advantage of unplanned opportunities as they occur.

e. Do not include too much information. Limit the choice of animals and topics to those that are essential.

f. Schedule 2 hour blocks of training time, as a general rule.

g. Provide time for breaks between classes.

h. Set aside time for the trainees to get from one place to another.

i. Set aside 2 hours each week for reviews (1 hour before the exam and 1 hour after). Allocate 1 hour of exam time weekly for each animal.

j. Try to match weekly theme in livestock to those going on in other components.

## C. CARRYING OUT THE LIVESTOCK COMPONENT

### 1. INTEGRATED DESIGN

It should be remembered that livestock training as described in this manual is not designed to stand alone. It and the other components combine to make an integrated Agricultural Extension training for the volunteer. For more information on this integrated design refer to Volume 1 of this manual.

### 2. TRAINER'S ROLE

The trainer will be seen by trainees as an "expert" in his or her field during the early days of training. However, it is the work of the trainer to eliminate the barriers created by being viewed as an "expert" and strive to remain a facilitator. The trainer's job is to create experiences and sessions that place the trainee in an active role of learning and allow the energy of the group to create a constructive learning environment. The trainer should not provide easy answers, but should assist the trainees in becoming knowledgeable through the use of continued questions, group problem solving and reference to appropriate readings.

### 3. TRAINEE'S ROLE

Trainees take responsibility for the daily feeding, watering, and caring for the animals, keeping field notebooks, making daily observations on the health of the animals, and keeping daily feed consumption records. Trainees take an active, responsible role in their learning. These activities serve to increase the confidence and credibility of the volunteer as he or she masters new technical skills. The time spent observing the animals allows the trainee to learn what is normal, healthy animal behavior and to distinguish it from the behavior of a diseased or abnormal animal. Ability to distinguish between the two is critical to disease diagnosis and making management decisions. Watering and feeding is normally done on a rotating basis during training with 3 or 4 trainees responsible each day (this number will vary depending on the size of the group and the number of animals).

### 4. TRAINING FEATURES

There are several aspects of the livestock training program that should be highlighted.

#### Class and Field Sessions

As mentioned earlier livestock training should have approximately a 60/40% ratio between field and class sessions. The sessions should be designed to complement one another. In other words, the field sessions can be used as the experience step of the experiential learning cycle and the class can serve as a tool in the reflection and generalization stages. It is important that the skill be learned first and then be placed in the context of livestock management and development work. In both the class and the field, the trainer should assist the trainee to learning but should not do the work for the trainee. Each trainee should demonstrate that they have learned the skill. The application stage of the experiential learning cycle for each skill learned comes when the trainee begins to train a counterpart in the skill he or she has learned.

## Farm Visits

Farm visits can be valuable for the trainee to begin to use the skills learned. Ideally, the farm visit should be conducted under the following conditions. First, the farmer should be working with the same animals and at a similar production level to those that the trainee will be working with in-country. Second, the farmer must be receptive to having trainees on his or her farm and willing to both answer their questions and allow them to work with his or her animals. Third, trainees can practice some of their organizational skills in setting up the farm visit and demonstrating their extension skills during the actual visit. Finally, trainees should not be asked by trainers to demonstrate a technique that he or she is not yet comfortable with. To do so would run the risk of injuring the animal and damaging the confidence and credibility of the trainee.

## Technical Training Goals

The trainer should refer to the technical training goals included in the Technical Guidelines, Chapter III. The purpose of the goals is to allow a trainee and the staff to easily assess progress of each trainee and to narrowly define tasks so that they can be completed in steps. Not all of the goals will apply in all training programs. Depending upon which animals are to be used in training, the overall length of the training, local conditions, the type of work the trainee will do as a volunteer, staffing patterns, and the skill levels of the trainees when they start training, these objectives will need to be altered. We have presented a full range of training objectives for 4 animals. The trainer will have to adjust these to fit each different training situation.

## Examinations

Exams should be used as a learning tool to enable the trainee, as well as the staff, to assess their progress on a weekly basis. The material to be included in an exam should be made clear to each trainee prior to the exam. The way to do this is to schedule a review session and then remind the group of the specific training goals which will be addressed on that week's exam. The results of the exam should be discussed with the trainee in the weekly feedback session. Exams should challenge the trainee to think and use the knowledge they have gained. Rote memorization makes for a poor exam and learning tool. They should help to point out the trainees determine whether they have mastered the skill called for in a particular goal. There is a sample exam in the appendix.

## The Development Continuum

The 5 components of livestock development (Nutrition, Management, Diseases & Parasites, Genetics, and Housing) and the developmental continuum of high to survival production levels should be the hallmarks of training. Each of the "hands-on" skills taught should be examined in light of these factors to determine the appropriateness of each practice in the individual environment where the trainee will work. It is the ability to analyze and problem solve that will take each of these skills and make them sound for application in the various settings where trainees will serve. To learn a skill and not the implications of its use in the local environment may cause a volunteer to impede rather than furthering it.

## Scenarios in Livestock Management Planning

The livestock management planning exercises contained in the guidelines are designed to have the trainees examine a livestock operation (either real or fictional) and then make management decisions based on local conditions, resources, and priorities (usually making more money and working less). They are used at the end of training when trainees can begin to evaluate the skills they have learned and make sense of them as they apply to development. In these sessions it is critical for the trainer to be a facilitator/questioner and to have the ideas flow from the trainees. It is best to use actual livestock operations that the trainees have visited as examples. If this is not possible then the trainer can draw up scenarios that are typical of the type of livestock operations that the trainee will encounter in-country.

# CHAPTER II: CURRICULUM OF THE LIVESTOCK COMPONENT

## A. LIVESTOCK SESSION LIST ORGANIZD BY SKILL GROUP

| | | Time |
|---|---|---|
| SKILL GROUP I: | Livestock Development | |
| Session 1: | Orientation to Livestock Training | 2 hours |
| Session 2: | Introduction to Nutrition | 2 hours |
| Session 3: | Introduction to Feeds | 2 hours |
| Session 4: | Introduction to Disease | 2 hours |
| Session 5: | Farm Visits | 20 hours |
| SKILL GROUP II: | Swine | |
| Session 1: | Overview | 1 hour |
| Session 2: | Housing & Construction | 4 hours |
| Session 3: | Feed Rations | 2 hours |
| Session 4: | Swine Production Fieldwork | 4 hours |
| Session 5: | Diseases and Parasites | 2 hours |
| Session 6: | Recordkeeping | 2 hours |
| Session 7: | Selection | 1 hour |
| Session 8: | Reproduction | 1 hour |
| Session 9: | Production Planning | 4 hours |
| SKILL GROUP III: | Rabbits | |
| Session 1: | Overview | 2 hours |
| Session 2: | Construction | 4 hours |
| Session 3: | Recordkeeping | 2 hours |
| Session 4: | Reproduction (Breeding & Sexing) | 2 hours |
| Session 5: | Slaughter and Post Mortem | 2 hours |
| Session 6: | Diseases and Parasites | 2 hours |
| Session 7: | Production Planning | 4 hours |
| SKILL GROUP IV: | Poultry | |
| Session 1: | Preparation for Day Old Chicks | 1 hour |
| Session 2: | Construction | 2 hours |
| Session 3: | Handling and Culling | 1 hour |
| Session 4: | Newcastle Vaccination | 1 hour |
| Session 5: | Feeds and Nutrition | 2 hours |
| Session 6: | Fowl Pox Vaccination | 2 hours |
| Session 7: | Poultry Diseases | 2 hours |
| Session 8: | Comparative Fowl Raising | 2 hours |
| Session 9: | Production Planning | 2 hours |
| Session 10: | Slaughter and Post Mortem | 2 hours |
| SKILL GROUP V: | Goats | |
| Session 1: | Introduction and Overview | 2 hours |
| Session 2: | Anatomy and Castration | 2 hours |
| Session 3: | Construction | 4 hours |
| Session 4: | Reproduction | 1 hour |

| | | |
|---|---|---|
| Session 5: | Ruminant Nutrition | 2 hours |
| Session 6: | Rations and Forages | 2 hours |
| Session 7: | Internal and External Parasites and Vitamin Shots | 2 hours |
| Session 8: | Diseases | 2 hours |
| Session 9: | Production Planning | 4 hours |

NOTE: This list does not reflect the actual order of sessions to be used in a training. There is no one best sequence (for scheduling suggestions see the sections on scheduling and carrying out training.) The time alloted for each class is also a suggestion. The actual time you spend on each session will depend on the emphasis of your training and local resources.

## B. SESSION PLAN FORMAT

The following page defines the elements of each session plan.

## C. LESSON PLANS

Lesson plans for each of the livestock sessions follow the lesson plan format.

Skill Group (Number)
Skill Group Title
Session Number, Page Number

## Title of Session

| | |
|---|---|
| Time: | Total time to present the session. |
| Goals: | Expected outcomes and skills transferred in this session, written to trainees. |
| Overview: | A brief summary of what is to happen in the session, mentioning related sessions, training events, and themes. |
| Activities: | The steps composing each session is composed are described in detail here in sequence. |
| "Summary" | The left column may include an optional phrase summarizing each step. |
| Materials: | Handouts and supplies used in the session are listed here. |
| Trainer Notes: | Advice and explanation of activities and steps; different opinions and approaches to the topic in the session are all included here. |
| Resources: | Books, manuals, and people providing information beyond the scope of this session are listed here. |

# ORIENTATION TO LIVESTOCK TRAINING

Time: 1 hr. barn
1 hr. classroom

Goals:

1. To encourage responsibility for the care and feeding of the animals.
2. To understand the training objectives and how to use the guidelines to prepare for sessions during the training period.
3. To become familiar with the five components of animal raising and the developmental continuum of high level to survival level production.

Overview: This session sets the tone for the livestock component of training. The trainees are introduced to "their animals" and shown how to feed, water, weigh, and keep records on the animals. Responsibility for developing a schedule for feeding and providing water for the animals is shared during the training period.

Activities:

| Time: | |
|---|---|
| 5 Min. | Trainer states goal number one and the relevance of the session. |
| 40 Min. | Trainees are oriented to the barn where they learn how to care for the animals. This includes feeding, watering, weighing feed and animals, and keeping records. |
| 15 Min. | Inform trainees of their responsibility for the care of the animals during the training cycle. In a group, trainees decide how the feeding schedule will be developed and share this responsibility. |
| 10 Min. | The session moves to the classroom. Trainer states goals two and three and their relevance to training. Guidelines and Practical Poultry Raising Manual are handed out. Training objectives are discussed and reading assignments which correspond to the sessions are emphasized. |

15 Min. The five components of animal training are introduced by the trainer and the development continuum is explained.

30 Min. Several topics on Livestock development are discussed, such as, why some animal projects fail, advantages of native breeds, credibility techniques in extension for development workers and multi-objectives for raising animals by farmers in developing countries.

5 Min. Critique the two hour session with trainees.

Materials:

.Livestock guidelines
.Practical Poultry Raising Manual
.Demonstration unit on farm with animals
.Feed and equipment

Trainer Notes: The first session may appear to be a lecture rather than the desired discussion because trainees are receiving the reference material during the class session. In order to effectively use the other methods of training, trainees must be strongly encouraged to take more responsibility for their learning and read the background material before coming to the session.

During this session many questions about the animals will be asked by trainees. It is important for the trainer to focus on the goal of the session and also be sensitive to the questions asked and compliment trainees during the process. However, many questions will be answered during the course of training either by their own resourcefulness and/or facillitation by the trainer.

# INTRODUCTION TO NUTRITION

Time: 2 hr. Classroom Session

Goals:

1. To develop an understanding of animal nutrition.
2. To develop a clearer understanding of their own nutritional needs and those of the people they will be working with.

Overview: This session is presented as a discussion of assigned reading. It is introduced before dealing with specific nutritional requirements of individuals animals. Because of the similarity between animals and man, basic nutritional concepts apply to both. Therefore, this session can also be applicable to a health and nutrition objectives of the core component of training.

Activities:

Time:

10 Min. State goals and relevance of the session.

50 Min. Ask if anyone has any questions on the reading. Explain unclear concepts, definitions, etc. In general review the reading.

50 Min. Introduce possible topics for discussion such as: What types of nutritional deficiencies will you see overseas with man and animals?

- Can one justify feeding animals when people are hungry? What role does nutrition play in the occurrence of disease?
- How will you adapt to a change in diet and still satisfy the nutritional requirement?

10 Min. Trainer asks trainees to critique session.

Materials:

- Livestock Guidelines
- Where There Is No Doctor
- Board and chalk

Trainer Notes: It is important that trainees read the material before the session.

The opportunity should be given to other trainees to answer questions that may arise from other trainees.

Coordination between Livestock trainers and Extension trainers should help reemphasize important portions of the topic, but at the same time not make repetition a hinderance to learning.

## INTRODUCTION TO FEEDS

**Time:** 1 hr. Classroom Session
1 hr. Barn Session

**Goals:**

1. To understand the different types of animal feed stuffs.
2. To learn how to mix protein concentrates with carbohydrates by using the Pearson square method.
3. To learn how to increase the protein concentration of feeds by mixing two or more ingredients.

**Overview:**

The first part of this session is in the classroom and consists of two parts. In the first part trainees discuss the different types of feeds mentioned in the reading. In the second part trainees analyze a feed mixing problem and then solve one on their own.

The second part of the session trainees work in two groups in the barn mixing three ingredients in correct proportions determined by the problem solving session in class.

This session prepares trainees to consider different feed ingredients and how to use them to produce a more nutritious feed.

**Activities:**

| **Time:** | |
|---|---|
| 5 Min. | State goals and relevance of the session. |
| 25 Min. | Facilitate discussion on the assigned reading, clearing up any confusion about the reading. Trainer checks if trainees understand the different types of feedstuffs. |
| 25 Min. | Introduce a sample feed mixing problem, using concentrate and carbohydrate feeds and using the Pearson method. Trainees learn how to use the square method. |
| 25 Min. | Present another feed mixing problem based on the feed ingredients available in the barn.<br>Ask trainees to solve the problem using Pearson square. Trainer makes sure all understand the answer. |

35 Min. Trainees divide into two groups and mix the three ingredients based on their calculations determined in class. This is done in the barn.

5 Min. Trainees are asked to critique the session.

Materials:

.Feedstuffs (e.g. corn, soybean meal. wheat bran etc.)
.Shovels, hand mixers, etc.
.Poultry Guidelines
.Practical Poultry Raising Manual

Trainer Notes:

Since math is involved in this session trainees should feel comfortable doing simple math. Trainer should assist those having difficulty.

Feed can be mixed on the floor using shovels. It should also be fed to animals suitable for the type of feed mixed.

Cost of feed ingredients and final mixture can be incorporated into this session.

## INTRODUCTION TO DISEASES

Time: 2 hr. Classroom Session

Goals:

1. To understand the causes, transmission, prevention, and treatment of animal diseases.
2. To understand health needs and how to maintain them.
3. To become more sensitive to health needs of their community overseas.

Overview: This session is a discussion on an assigned reading from the Livestock Guidelines. Any questions about the reading are answered by either trainees in the group or the trainer. Trainees are encouraged to discuss possible health problems they may encounter overseas with animals, the people they live and work with, and themselves.

Activities:

Time:

10 Min. State goals and relevance of the session.

50 Min. Ask trainees if they have any questions about the assigned reading.

Encourage trainees to explain concepts that other trainees may have had difficulty comprehending.

Trainer may encourage discussion by answering questions with questions and also allowing trainees to think through answers to questions.

50 Min. Trainer facilitates a discussion on possible topics stemming from the reading. Examples: What zoonotic diseases will they encounter overseas?

How will health and nutrition relate to each other when they are overseas?

What type of vaccine will you be receiving before and while you are overseas? Based on the disease reading what is the value of recordkeeping for animals? etc.

10 Min. Trainer asks trainees to critique session.

Materials:

.Livestock Guidelines
.Extension Guidelines (Immunization Resources)
.Where There Is No Doctor

Trainer Notes: Trainees should read the material before coming to class.

If trainees have difficulty with reading, session should be run like a lecturette.

## FARM VISITS

**Time:** 3 hrs. (20 hrs. total time)

**Goals:**

1. To visit farmers who are working with the same animals being studied in the training. (Note: Schedule two to four hours for each of the different species used during training.

2. To practice a skill that has been learned during training (debeaking, tail docking, etc.) in a farm environment.

3. To provide an opportunity to practice community analysis and ag extension skills.

**Overview:** This is a three hour exercise spent entirely in the field. The trainees travel to a farm where they greet the farmer, take a quick tour of the farm, and then settle in to work on a task previously agreed upon by the trainer (or trainee) and the farmer. When the task is completed the trainees thank the farmer, ask him a few questions, and then depart. The trainees reflect on the visit and the work that was done and generalize about how that task and visit would be performed in their host country.

**Activities:**

**Time:**

30 Min. Trainees travel to the farm.

30 Min. Trainees meet the farmer, ask a few questions, socialize, and take a quick tour of the farm. (The trainer acts as a prompter but remains at the back of the group and allows the trainees to interact with the farmer.)

1 Hr. Perform the task or tasks (such as castrating, debeaking, ear tatooing, or hoof trimming) in the manner preferred by the farmer. The farmer might first demonstrate the practice and then each trainee should try it. The trainer observes.

1 Hr. Dialogue on the farm visit. The trainer should ask questions like:

- How did you feel while meeting and socializing with the farmer?

- Did socializing serve a useful purpose?

- How did the farmer's demonstration compare with the approach to method demonstrations taken in training?

- What was the most limiting factor in the farmer's operation?

- What major disease or parasite problems did you observe?

- Was the skill or technique used appropriate to that farmer's level of development?

- Was there anything about your interaction with the farmer that surprised you?

- How will you determine if that particular skill is appropriate to use in your village?

Materials:

- All veterinary kit materials needed for the task to be performed.
- Transportation
- Field notebooks
- Extension classes on community analysis and on ag extension
- Notes on farm visits in the Livestock Manual "Carrying Out a Livestock Training".
- Local farmer and his/her animals
- Trainee's work in setting up the farm visit

Trainer Notes: This lesson plan was used to plan only 3 hours of the 20 total hours spent in farm visits.

## OVERVIEW

**Time:** 1 hr.

**Goals:**

1. To familarize the trainees with the technical training goals for swine.
2. To introduce to the trainees the idea of swine production as a system made up of many factors.
3. To reinforce the communication, analysis, and problem solving skills as well as technical capability.

**Overview:** This is a classroom exercise. It includes an examination of the swine training objectives, an examination of the 5 factors of livestock development (as they relate to swine), in terms of the developmental continuum. The importance of being able to realistically determine production levels is emphasized, along with the skills needed to arrive at these decisions.

**Activities:**

**Time:**

15 Min. The trainees will read over the swine technical training goals and ask questions to clarify any confusion concerning goals.

35 Min. Trainer initiates dialog on low and high swine production levels in relationship to housing, nutrition, genetics, disease and parasites, and management. Specific examples from the States and from the host country should be cited.

10 Min. The trainees contribute ideas about the types of skills needed for decision making in swine projects. The trainer helps to guide the discussion and relate it to specific host country situations.

**Materials:**

.Blackboard and chalk
.Pencil and paper
.Overview sessions from other livestock classes
.Extension classes on communication and problem solving
.The livestock training goals and guidelines

## HOUSING AND CONSTRUCTION

**Time:** 4 hrs.

**Goal:**

1. To gain a basic knowledge of swine housing and design.
2. To make a creep feeder, feed, and water containers out of materials most usually available in country of assignment.

**Overview:** The initial classroom time covers various types of housing for swine production. Points of emphasis in the class will be the pros and cons of different types of housing and their relationship to other management factors and levels of production.

During field time trainees will address the problems of feed and water containers and of feeding younger and older animals together. They will decide how to solve these problems and construct the appropriate equipment.

**Activities:**

| **Time:** | |
|---|---|
| 5 Min. | Trainer states and explains the session objectives. |
| 30 Min. | Class discussion on swine housing with respect to health problems, management, feeding, and levels of production. |
| 25 Min. | Trainees discuss problems they have seen in feeding and watering the training program animals, decide how to overcome these problems, and make plans for the necessary construction. Trainer participation should be to help trainees focus their ideas along the lines of what they might be doing in their country of assignment. |
| 10 Min. | Trainees gather and prepare materials for feed and water tub construction. |
| 50 Min. | Using cement and plastic tubs trainees make feeders and waterers and clean up. |
| 20 Min. | Trainees gather and prepare materials for construction of a creep feeder. |
| 100 Min. | Trainees build a wood creep feeder. |

**Materials:**

- Blackboard, chalk
- Paper, pencil
- Calculator
- Cement, sand, plastic tubs, shovel
- Lumber (2 by 4), nails, hammers, measuring tape
- Livestock Guidelines
- Small Scale Pig Raising, Dick Loon, Garden Way, 1978, p. 82

# FEED RATIONS

Time: 2 hrs.

Goals:

1. To balance 1 high production level feed ration for swine using at least 4 ingredients.
2. To discuss the conflict that arises over human and animal competition for the same feeds.

Overview: This will be a classroom session. The class will be divided into 3 sections. First, the trainer will demonstrate how to balance 1 feed ration. Second, each trainee will individually balance a feed ration. Third, trainees and trainer will dialog on the conflict between human and animals feeds.

Activities:

| Time: | |
|---|---|
| 5 Min. | Trainer introduces the class and its objectives. |
| 45 Min. | Trainees look over the N.R.C. nutrient requirements for swine. Trainer, demonstrating silently, goes through the steps to balance 1 high production feed ration that contains 5 feedstuffs. Trainees observe and, if necessary, take notes on the procedure followed by the trainer. Trainees then summarize the steps and trainer clarifies as needed. |
| 60 Min. | Each trainee selects 4 tropical feedstuffs commonly available in his or her host country and balances 1 moderate level production ration for swine. (See Trainer Note) |
| 10 Min. | Trainer raises the issue of scarcity of animal feeds in the host country. The trainees discuss the conflict of human vs. animal consumption of grains and how they might resolve it in their villages. |

Materials:

- Blackboard and chalk
- Paper and pencils
- Calculators
- Diet for a Small Planet

- .Extension Class on Volunteer health and well being
- .Livestock classes: "Introduction to Nutrition", "Introduction to Feeds".
- .Feeds and Nutrition by Ensminger
- .NRC nutrient requirements for swine
- .Extension class on Ag. Development

**Trainer Notes:** If the ration is not completed at the end of the class he or she can turn it in later.

## SWINE PRODUCTION FIELD WORK

Time: 4 hrs.

Goal: Trainee gains confidence handling swine and acquires technical skills necessary to assess swine operations.

Overview: This field class will give trainees experience handling animals, needed for credibility at their sites. Direct field experience performing certain management practices will also give trainees the ability to assess swine projects and determine additional inputs or modifications of local practices.

Due to the unpredictable nature of animal health and body functions a number of management practices can be performed. These practices can include assisting a farrowing sow, iron shots, clipping needle teeth, scours treatment, castration, vitamin shots, marking or identification and tail docking.

For all field work the trainer will begin by giving a demonstration of the work to be performed. The trainees will then prepare the necessary materials for, and do the necessary work under guidance of the trainer(s). Third, technical information will be discussed. The pros and cons of each management practice performed will be discussed emphasizing appropriateness to various levels of production.

Activities:

| Time: | |
|---|---|
| 15 Min. | Trainer conducts a method demonstration of clipping needle teeth and solicits feedback on demo. |
| 20 Min. | Trainees clip one set (2 teeth) of needle teeth each. |
| 15 Min. | Trainer conducts a method demonstration of giving iron shots and solicits feedback. |
| 20 Min. | Trainees prepare injection and inject a piglet with injectable iron. |
| 15 Min. | Trainer conducts a method demonstration of practices involved in castration. |
| 60 Min. | Each trainee castrates one male piglet using a razor blade or knife. |

| | |
|---|---|
| 15 Min. | Trainer conducts a method demonstration of cutting an umbilical cord and dipping it in iodine. |
| 50 Min. | Trainees assist in birth of piglet and cut and dip the umbilical cord. |
| 15 Min. | Trainer conducts a method demonstration of tail docking. |
| 15 Min. | Each trainee docks a tail of a piglet. |

Materials:

.Injectable Iron 50 cc bottle
.5 10cc syringes
.16 gauge 3 - 1 1/2 " needles
.14 gauge 3 - 2" needles
.5 50cc syringes
.Cotton balls
.Alcohol
.Toenail clippers
.Sharp knives or razor blades
.Oxytocin
.Iodine
.Farrowing Gilt or sow
.Baby pigs
.Paper and pencil
.Livestock Guidelines
.Small Scale Pig Raising, Van Loon, Garden Way, 1978, p. 150-169

Trainer Notes:

1. The method demonstration format provides a forum for discussing technical information while modeling one of the techniques the trainess will use in the field.
2. As trainees practice the skills, the trainer should respond to questions and otherwise incorporate sharing of technical information.
3. This class can be split into 2 two hour sessions if necessary.

# DISEASES AND PARASITES

**Time:** 2 hrs.

**Goals:**

1. Trainees will learn the life cycle of common internal and external parasites of swine and diagnose and treat a pig for these parasites.
2. They will learn information on the prevention, diagnosis, and treatment of 2 common swine diseases in their host country.
3. Trainees will become aware of swine zoonotic disease, internal and external parasites, and the effects these can have on a human host.
4. Trainees will handle a pesticide safely and demonstrate an awareness of the dangers of pesticide use.
5. The trainees will be asked to address the issue of appropriate treatment and control measures in relation to different levels of production.

**Overview:** The first hours will be spent in the barn deworming pigs and spraying them for ticks and fleas. The second hour will be spent in the classroom discussing diseases and parasites, evaluating the practices they have learned and their relation to different levels of production, and the effects of pesticide safety, parasites, and zoonotic diseases on a volunteer's health.

**Activities:**

| **Time:** | |
|---|---|
| 5 Min. | Trainer introduces the goals. |
| 20 Min. | Trainees treat the pigs for internal parasites (roundworm and tapeworm). |
| 30 Min. | Trainees treat for ticks and fleas by spraying with either malathion or dipterex. |
| 15 Min. | Trainer discusses the life cycle, treatment, diagnosis and prevention of swine parasites. |
| 20 Min. | Trainees and trainers discuss the prevention, diagnosis, and treatment for 2 swine diseases common in the host country. |

10 Min. Trainees discuss how pesticides, swine parasites, and zoonotic diseases can potentially affect their health as volunteers.

20 Min. Trainees divide into 3 small groups. Each group discusses the appropriateness of the techniques they have learned to one of three (3) levels of production (low, moderate, high). Groups share findings in the large group.

Materials:

.Paper, pencil
.Blackboard, chalk
.Backpack sprayer and/or watering can
.Measuring spoons
.Malathion 50% liquid
.Atgard or Thiabendazole Piperazine
.Small Scale Pig Raising, by Van Loon, pgs. 160-194
.Instructions on the Pig Wormer and Malathion
.Where There Is No Doctor, by Werner, pgs. 140-145
.Crops Guidelines (Pesticide Safety), pgs. 43-57

## RECORD KEEPING

**Time:** 1 hr.

**Goal:** Trainees will keep production records on the training program swine project and know their importance and necessity in swine production.

**Overview:** Record keeping will be used as a tool to improve trainee knowledge of swine production. The one hour class will be devoted to why record keeping is necessary, how it is to be done, and how to use the information in management and, production. All this work will be considered in the context of development work.

Trainees will each make a record book in which, on their own time, they will keep feed, health, mortality, production and cost records. Completion of the record book will be a requirement of the swine production segment.

**Activities:**

**Time:**

| | |
|---|---|
| 10 Min. | Trainees brainstorm objectives of record keeping. |
| 5 Min. | Trainer distributes record book examples. |
| 15 Min. | Trainer explains how records are to be kept and answers questions on procedures. |
| 30 Min. | Trainees in small groups discuss record keeping as it pertains to swine production. (Focal points of the discussion should be:<br>-information that can be gained from records;<br>-how to use records as a tool of production;<br>-the importance of records in extension and development work. |

**Materials:**
- .Notebooks, pencil
- .Blackboard, chalk and calculator
- .4H Swine Manual and Record, Cooperative Extension Service, Purdue University
- .Farm Accounting and Business Analysis, James and Stoneburg, Iowa State University Press, 1974, p. 108

## SELECTION

**Time:** 1 hr.

**Goal:** Trainees will be familiar with methods of swine selection based on conformation and production characteristics.

**Overview:** To be successful at swine production on any level a person must have a basic knowledge of swine anatomy. This knowledge can be used as a tool in selecting and breeding swine for higher production.

This classroom exercise focuses on conformation as an important way of evaluating animals for meat or fat production. Trainees learn observation and examination skills necessary for considering usefulness of swine. Applying methods of selection to small scale vs. large scale farmers in country(ies) of assignment will be discussed.

**Activities:**

| Time: | |
|---|---|
| 10 Min. | Trainer explains basic swine anatomy. |
| 10 Min. | Given several photographs of swine, trainess in small groups will rank them according to conformation characteristics and common faults. Rankings and the reasons for the rankings are shared in the large groups with the trainer commenting as necessary. (See Trainer Note.) |
| 10 Min. | Trainees share ideas on conformation as it relates to production (meat, fat, reproductive). |
| 15 Min. | Trainess and trainer discuss swine improvement through selection for physical characteristics and/or production. Trainees identify characteristics of good breeding stock. |
| 15 Min. | Trainees consider the problem of applying selection techniques to different levels of production. Trainer solicits ideas on constraints and opportunities of small scale and large scale swine production. |

**Materials:**

- .Blackboard, chalk
- .Handouts, livestock guidelines
- .Paper, pencil
- .4H Swine Manual and Record, Cooperative Extension Service, Purdue University
- .Swine Science, M.E. Ensminger, Interstate, 1970, pp. 71-86
- .Small Scale Pig Raising, Van Loon, Garden Way, 1978, pp. 7-44

**Trainer Note:** If trainees have access to enough adult pigs, real animals can be used instead of photographs.

## REPRODUCTION

| | |
|---|---|
| **Time:** 1 hr. | |
| **Goal:** | Trainee will be familiar with the basic aspects of swine reproduction. |
| **Overview:** | One hour of classroom time will be devoted to a discussion of swine reproduction. Topics to be covered will include puberty, heat cycle, breeding, gestation, farrowing, lactation, and weaning. In addition the discussion will identify those factors of reproduction which may be affected by management and those which may not. |

**Activities:**

**Time:**

| | |
|---|---|
| 10 Min. | Trainer ask trainees to refer to their field notebooks for any observations of onset of puberty, estrus, or signs of farrowing. Trainees share observations. |
| 10 Min. | One trainee explains puberty in swine and asks trainees to brainstorm possible management of other factors that may affect the time of its onset. (See Trainer Notes.) |
| 10 Min. | One trainee explains the heat cycle, estrus, and asks trainees to cite methods of detecting estrus. |
| 10 Min. | One trainee discusses swine breeding, methods of facilitating successful mating and factors which may or may not contribute to success. |
| 10 Min. | One trainee explains the gestation period and leads a discussion on preparation for farrowing and signs of farrowing in an expectant sow. |
| 10 Min. | One trainee facilitates the group in analyzing a scenario related to lactation, weaning, and rebreeding with respect to management level and available resources. |
| | Trainees who facilitated parts of this session request and receive feedback. |

Materials:

.Blackboard, chalk
.Pencil, paper
.Livestock Guidelines
.Small Scale Pig Raising, Van Loon, Garden Way, 1978, pp. 131-150

Trainer Notes:

1. Trainess will be expected to keep records on training animals pertaining to reproduction. This will be done during free time or concurrently with other activities involving recordkeeping.

2. The trainer will want to work beforehand with those trainees who are to facilitate parts of this session.

# PRODUCTION PLANNING

**Time:** 4 hrs.

**Goal:** Trainee will gain ability to analyze swine projects in terms of profit and loss.

**Overview:** The economics of high and low production operations will be analyzed with regard to nutrition, housing, disease, and management. A thorough understanding of these four areas and the variable costs involved therein are necessary to determine the feasibility of possible projects, or to make suggestions concerning the improvement of existing ones.

This exercise will be conducted in the classroom. Included in the session will be mathematical principles used in profit-loss analysis for livestock operations; and a discussion and cost analysis of two swine production operations (high production-low production) with regard to assumptions, available resources, inputs, housing, disease, nutrition, and management.

Trainees will be asked to analyze their swine project using records they have kept and information they have gathered. Each trainee is required to provide a written analysis of the project.

Subjects which will be emphasized continually throughout the class are information gathering skills, assessment techniques necessary for planning, and how to make recommendations as an agriculture extension agent.

**Activities:**

**Time:**

| | |
|---|---|
| 15 Min. | Trainer introduces the concept of production planning by asking trainees to review their records and give opinions as to which information they think has bearing on profit and loss. |
| 60 Min. | Trainer goes over the mathematics useful in analyzing swine production for profit and loss.<br>Trainees will share questions concerning the mathematics previously discussed. |

45 Min. Using a description of a small scale-low production operation, based on information available about country of assignment, trainees in small groups analyze the situation and determine whether it merits change or not.

60 Min. Given a description of a high production operation, trainees in small groups make recommendations concerning the operation.

60 Min. Trainees in groups begin to analyze their swine project for profit and loss. (The trainer should be available as a resource person.) A written analysis of the project, with recommendations, will be due within three days. Trainees will use records they have kept and will be responsible for gathering information such as market price, feed price, etc.

Materials:

.Blackboard, chalk
.Paper, pencil
.Calculator
.Record book
.Livestock Guidelines
.Farm Accounting and Business Analysis, James and Stoneburg, Iowa State University Press, 1974, pp. 108-123, 208-249
.Local Newspaper, Receipts from feed store

## OVERVIEW

**Time:** 2 hrs.

**Goal:** To examine and analyze different rabbit projects as management systems using the development continuum framework.

**Overview:** Trainees will have received an introduction to the development continuum of high to survival production with the 5 principal areas of nutrition, management, diseases and parasites, genetics, and housing as it relates to rabbits. Trainees visit 2 different rabbit projects involved in different levels of rabbit care and production during the first hour. The second hour is spent discussing rabbit production, the developmental continuum, and rabbit raising in their host country.

**Activities:**

| Time: | |
|---|---|
| 10 Min. | Trainer introduces the class and reviews training goals. |
| 45 Min. | Trainer reminds trainees of the development continuum and recalls the discussion during the barn walk-through in Livestock Development Session I. Trainees visit 2 different rabbit projects. Trainer reminds trainees of the value of observation and using their field notebooks for recording these observations; Feeds being used, breeds, type of housing, obvious management problems, presence of diseases and parasites, etc. |
| 5 Min. | Break |
| 20 Min. | Trainees in small groups list similarities and differences between the 2 projects visited, and develop a group opinion on why there are differences between the two. |
| 30 Min. | Group reconvenes and shares findings. In the large groups, trainees rate each project (using the 5 component parts) from high to survival level production. Trainer elaborates on what actually exists in a high, moderate, and a survival level project, using specific examples. |
| 10 Min. | Trainer asks each trainee to write one example of how the development continuum might relate to possible future projects in the host country. |

**Materials:**

- .Cages
- .Rabbits
- .Classroom, chalk, blackboard
- .Field notebooks
- .The Livestock Training Guidelines
- .The Training Rabbit Project
- .The Extension Class on Problem Solving
- .A Local Rabbit Project

## CONSTRUCTION

**Time:** 4 hrs.

**Goals:**

1. To acquire knowledge of space requirements, basic construction techniques, and shelter requirements for rabbits.
2. To examine group process.

**Overview:**

In this session trainees gain basic knowledge of construction of rabbit hutches appropriate for their host country. Rabbits are delicate animals and due to their nature cannot be allowed to "free range" as can other animals. In order to have a viable project the trainees must have a basic knowledge of construction techniques. This session is split into 2 parts. The first part is 2 hours in length and includes activities 1 through 6. During this phase the group sees examples of different rabbit cages, decides how they wish to build theirs, organizes into small groups, list out the needed materials, and finally obtains all the materials needed to begin construction. The second part is also 2 hours in length and involves construction of the cages, waterers, and feeders. (It is probable that the cages cannot be completed in 2 hours and that trainees will need to finish them on their own time.)

**Activities:**

**Time:**

5 Min. 1. The trainer states which goals are to be completed and gives a brief introduction to the topic and how the 4 hours are to be used.

20 Min. 2. Trainees will individually examine 2 different examples of rabbit cages (this could include the temporary housing for the rabbits in the P.C. project and one local project), concentrating on design possibilities, measurements, etc.

25 Min. 3. Trainer facilitates a large group discussion in which trainees analyze the 2 cage designs they have seen and reflect on their differences (use of local materials, usefulness, and appropriate levels of development for their host country).

20 Min. 4. Trainer distributes design plans and trainees analyze them in small groups, comparing these designs with the two designs they have examined physically. In the large group, trainees decide on the design to be used for the training center's rabbit project, including cages, waterers, and feeders. Trainees draw up a list of needed materials and organize into small task groups.

10 Min. 5. Trainees in their task groups reflect on the group's process in Step 4.

30 Min. 6. Trainees obtain the needed materials (through purchase and scrounging around locally).

120 Min. 7. Trainees build the cages, waterers, and feeders. Staff members provide needed information and support, and observe group process.

10 Min. 8. Trainees and trainer discuss how they worked together as a group.

__Materials:__ (Subject to revision based on the group's decisions)

.Hammers, nails, saws, wood, wire mesh flooring, bottles, cans, and a square.
.2 physical examples of different cages.
.Design plans for waterers, feeders, and cages.
.The P.C. rabbit training project
.__Raising Rabbits__ by Harlan Attfield
.__Raising Rabbits the Modern Way__ by Bob Bennett
.Extension classes on Community Organizing.

## RECORD KEEPING

Time: 2 hrs.

Goals:

1. To introduce the concept of keeping precise feed, breeding, and production records for rabbits to the trainess.
2. To establish a record keeping format to be used in future projects.
3. To learn how to tatoo numbers into the rabbit's ears and examine this practice in the context of a traditional village structure with illiterate farmers.

Overview: Due to the rapid reproduction of rabbits, precise breeding records are imperative to good management at all levels of production. Number tatooing is needed to keep track of each animal. For production planning and to keep profit or loss records and to determine feed/gain ratios records must be kept. The trainees are shown how to tatoo a number into the ear of a rabbit; then trainees tatoo. In the classroom, the group evaluates 2 different systems of record keeping and discusses their appropriateness to their future projects. From this trainees draw up their own record keeping system for feeding, breeding, and production.

Activities:

Time:

5 Min. Trainer introduces the class and goals.

10 Min. Trainer demonstrates how to ear tatoo a rabbit. (It is best to have one trainee securely hold the rabbit while another swabs out the ear with alcohol. Then the trainer should position himself so that the group can all see while he lightly tattoos in the number).

5 Min. Trainer solicits feedback on his or her demonstration.

40 Min. Trainees practice the procedure on several more rabbits. (The trainer should stand back and have one trainee hold the rabbit, one swab out the ear, and one more tatoo the number. Here the trainer can best work as a coach and be reassuring to those who are having difficulty). Trainer asks if any trainees felt ill at ease performing the procedure and facilitates expression of any such feelings.

40 Min. Trainer distributes 2 or 3 different examples of rabbit record keeping systems for the trainees to examine. The trainees discuss the points in the records to clarify the reason for each.

20 Min. Trainees in small groups select the better points from each system and develop a system they consider appropriate to their host country. Trainer facilitates the process.

Materials:

.Rabbits
.Ink
.Needles
.Cotton
.Alcohol
.3 sets of records
.Blackboard and chalk
.Pencils and paper
.Raising Rabbits by Attfield, pages 31 to 37
.Raising Rabbits the Modern Way by Bennett, page 77
.The P.C. Training Rabbit Project

# REPRODUCTION, BREEDING, and SEXING

**Time:** 2 hrs.

**Goals:**

1. To mate rabbits, determine the sex of an 8 week old rabbit, palpate a pregnant doe, and describe the reproductive cycle of rabbits.
2. To familiarize the trainees with these basic practices of rabbit raising and fit these practices into the developmental continuum.

**Overview:** The session is divided into 2 parts. The first part takes place in the barn where trainees mate 1 breeding pair, palpate the pregnant does, and sex the fryers. The second session occurs in the classroom where trainees reflect on the skills just learned, come to consensus on their validity in future projects, and apply what they have learned.

**Activities:**

**Time:**

5 Min. Trainees observe the breeding of a buck and doe. (Trainer should be sure to place the doe in with the buck and not vice versa. Breeding is best done in the cool of the morning or evening.)

10 Min. Trainer demonstrates the 3 correct ways of holding a small, a medium, and a large breed rabbit. Trainees practice holding the rabbits.

25 Min. Trainer demonstrates the proper method of sexing fryers. Small groups practice the procedure. The trainer circulates among the groups to answer questions and assist.

30 Min. Trainer demonstrates how to palpate a doe (at 14 to 21 days of gestation) to detect pregnancy. Again the group divides into subgroups to practice this procedure.

15 Min. Trainer leads a discussion on the use of these techniques and their applicability to host country projects in light of information gathered during the PTR. Trainer asks if anyone can think of different methods for determining the appropriateness of the techniques.

| | |
|---|---|
| 15 Min. | Trainees divide into pairs to discuss any discomfort they might have felt with any of the procedures just practiced. |
| 20 Min. | Trainer calls for questions on each stage of the reproductive cycle of rabbits. |

Materials:

- .Rabbits (fryers, does, and bucks)
- .Cages
- .Blackboard, chalk, and 1 Handout
- .Raising Rabbits - VITA
- .Raising Rabbits by Bob Bennett
- .The P.C. Rabbit Project
- .Guidelines

## FEED RATIONS

**Time:** 2 hrs.

| | |
|---|---|
| **Goal:** | To balance one high production feed ration for rabbits that meets the National Research Council requirements, using ingredients commonly found in tropical feedstuffs of their host country. |
| **Overview:** | Balancing an improved feed ration is the first step towards the development of a profitable rabbit project. Therefore, the trainees will spend time learning the nutrient requirements of rabbits, the relative nutrient values of various tropical feedstuffs, and how to balance the two. The class is divided into 2 sessions. The first session includes a discussion of high to low production feeds, rabbit nutritional requirements, National Research Council requirements, and the purpose of crude protein, metabolizable energy, calcium, phosphorus, and lysine in the diet. In the second session the trainees balance a feed ration to National Research Council requirements, using feedstuffs available in their host country. |

**Activities:**

| **Time:** | |
|---|---|
| 5 Min. | Trainer introduces the class goals. |
| 5 Min. | Trainer asks trainees to recall the introductory session on feeds and rations, and explains that today's session follows up on the earlier one with specific reference to rabbits. |
| 15 Min. | Trainer leads a discussion on high to low production feeds and their impact on rabbit production, using examples that are host country specific. |
| 20 Min. | Trainer presents the National Research Council Nutrient requirements for rabbits. Trainees discuss validity of the requirements in the development of projects, examining each point in detail. |
| 20 Min. | Trainer discusses the purpose of Metabolizable energy, Crude Protein, Calcium, Phosphorus, and Lysine in the balanced feed ration. |
| 10 Min. | Break |

| | |
|---|---|
| 45 Min. | Each trainee will balance one high production feed ration for rabbits. The trainer will work, as needed, with each trainee individually to assist in the balancing process. |

Materials:

.Blackboard, chalk
.Paper, pencils
.Calculators
.Feed and Nutrition by Ensminger
.National Research Council Nutrient Requirements for Rabbits
.The Livestock Guidelines
.Livestock Introduction to Nutrition and Feeds Classes
.Extension Class on Basic Nutrition Concepts

## SLAUGHTER and POST MORTEM

Time: 2 hrs.

Goals:

1. To become partially desensitized to the killing of animals.
2. To suspend emotional judgement and to observe how to properly skin a rabbit in order to preserve the pelt for tanning.
3. To learn the steps involved in a post mortem procedure.

Overview: To work in a rabbit project the trainee must know proper slaughter, dressing, and post mortem procedure if the project is to be profitable. The trainees split into 2 groups and one trainer goes with each group. Each 2 trainees will kill and field dress one rabbit. The trainer demonstrates post mortem procedure and the trainees practice the procedure on the rabbits they slaughtered.

Activities:

| Time: | |
|---|---|
| 5 Min. | Trainer introduces the class and goals. |
| | Trainer demonstrates how to slaughter a rabbit in the manner used in the host country. |
| 15 Min. | Trainer encourages trainees to express any ambivalent or negative emotions they experienced while observing the killing, while trying to help the trainees place this skill within a village context. (See Trainer Notes). |
| 10 Min. | Trainer hands up skins and prepares the carcass for the post mortem without commenting on the steps he or she is following. After observing, trainees in pairs review the steps followed by the trainer. |
| 35 Min. | The pairs repeat the procedure. (Due to the emotions involved in this task, at least 2 trainers should be available to provide assistance. This is a skill that can also be peer taught since there are usually trainees with this skill.) |
| 15 Min. | When the hide is removed, the organs should be laid out on a flat surface for examination. Trainer conducts a discussion on the physical positioning, identification, and characteristics of |

the various organs (heart, lungs, liver, stomach, intestines, kidneys, etc.), and points out any indications of disease, parasites, or abnormalities, pointing out the contrast between diseased and healthy organs.

30 Min. The pairs conduct a post mortem exam of the rabbit they slew, examining the organs in the same order and for similarities between the various rabbits, and share any indications of disease or parasite presence.

10 Min. At the end of the session the trainer will ask the trainees to reflect on what they learned technically from the session, how they dealt with their emotions, how this skill can be applied to their host country, and how overcoming negative emotions in this instance can be related to other aspects of adaptation.

Materials:

.Sharp knives
.Hammer or hoe handle
.Razor blades
.Twine
.Water and towels
.Rabbits (the more the better)
.The Peace Corps Rabbit Training Project
.A Local Rabbit Project (as a supply of additional Rabbits)
.Raising Rabbits - VITA - page 47 to 51

Trainer Notes: People who have not slaughtered animals often react with very strong emotions the first time(s) they observe or participate in slaughtering. The trainer must be acutely aware of and sensitive to these emotions. It is also important that trainees learn to place slaughtering of food animals in the context of Third World practices and nutritional needs and to relate the discomfort they may feel in this situation to the cultural adaptation process in general. Although the trainer(s) can provide much of the support which trainees often need during this activity, the value of peer support should be maximized.

## DISEASES and PARASITES

Time: 2 hrs.

Goals:

1. To become familiar with the common internal and external parasites of rabbits.
2. To recognize these parasites and be able to treat for them.
3. To receive information on the 3 most common rabbit diseases in their host country including their prevention, diagnosis, and treatment.

Overview: Rabbits are delicate animals that contract disease easily (especially in the tropics) when stressed. If these diseases are not prevented or cured they can destroy a project's profit. The class is split into 2 sessions. The first session involves treating rabbits for ear mites and coccidiosis; the second session deals with the prevention, diagnosis, and treatment for ear mites, coccidiosis, pneumonia, sore eyes, and caked udder.

Activities:

| Time | |
|---|---|
| 10 Min. | Trainer introduces the class and goals. |
| 10 Min. | Trainer asks trainees to individually refer to their field note books for references to diseases they have seen on field visits or in their own project, and indicates that today's session will provide direct experience in dealing with rabbit diseases. |
| 40 Min. | Trainees read the label on the sulfa drug used as a coccidiostat, mix it with water in accordance with the prescription, and give the treatment to a rabbit. The group also mixes up the 2:1 formula of vegetable oil and kerosene and swabs it into the infected rabbits ear. Trainer demonstrates as necessary. |
| 20 Min. | Trainer asks trainees to describe as best they can the symptoms for which they treated in the first part of the session. Trainer then discusses ear mange and coccidiosis, how they are detected, treated, and prevented. |

40 Min. Dialog on the 3 rabbit diseases. Using concrete examples trainees have seen in the field visits, trainer discusses the diagnosis, prevention, and treatment of the 3 diseases, referenced by specific conditions from the host country. With reference to the development continuum, the trainer dialogs with the group on the applicability of the practices learned today in their host country.

Materials:

- .Vegetable oil
- .Malathion
- .Cotton and sticks
- .Coccidiostat
- .Rabbits (preferrably diseased)
- .Blackboard, chalk
- .The Peace Corps Training Rabbit Project
- .A Local Rabbit Project

## PRODUCTION PLANNING

Time: 4 hrs.

Goals:

1. To perform a cost analysis to determine profit loss.
2. To apply feed/gain ration and production planning to realistic levels of projects in the host country.

Overview: This is a classroom session conducted during the last week of training. The first part involves determining the feed/gain ratio for rabbits and determining profit or loss margin. The second part covers how this data and process may affect their future projects. The third part will be to see how this analysis can be used in various levels of production, and should be related to realistic production levels for small farmers in the host country. The fourth part involves analyzing and making management decisions based on 2 different management level scenarios (one for moderate and one for survival production).

Activities:

| Time: | |
|---|---|
| 70 Min. | Trainees go into the local community to determine the price of feeds and meat from the local contacts. Trainees perform a cost analysis of their profit (including feed/gain ratios, cost of feeds, and sale price for meat). |
| 30 Min. | Trainer facilitates a large group discussion on the validity of this exercise for the trainees' future projects and about how a cost analysis could be undertaken in their villages. |
| 10 Min. | Break |
| 20 Min. | Discussion on how this cost analysis and feed/gain ratios can be used in production planning at all levels of management. Be host country specific and always provide examples from typical situations encountered in country. |
| 50 Min. | Working through a prewritten scenario for rabbit production at low management production levels, trainees make management decisions and recommendations for measuring profit concerning nutrition, diseases, management, genetics, and housing. Trainees work in small groups and trainer facilitates. |
| 60 Min. | The previous activity is repeated for moderate to high production levels. |

Materials:

.Livestock Production Planning Scenarios
.Livestock feed consumption records
.Raising Rabbits - VITA - pages 39 to 44
.Merck Manual of Veterinary Science

## PREPARATION AND CARE FOR DAY OLD CHICKS

**Time:** 1 hr. Barn

**Goals:**

1. To learn how to brood, feed, and care for 50 day old chicks.
2. To compare different methods of raising day old chicks (cage vs. floor housing).
3. To help them improve their observation and record keeping skills.

**Overview:** This session is held on the day the chicks arrive from the hatchery. Based on reading the Livestock Guidelines and Practical Poultry Raising Manual, and with the equipment provided, trainees divide in two groups. One sets up a deep litter floor system, with a metal hover and an electric light bulb as a source of heat; the other, a battery brooder cage system with a kerosine lantern as its source of heat. Besides learning how to raise chicks in two different housing systems, the trainees will compare and evaluate the systems by recording feed consumption and weigh gains of the two different groups.

**Activities:**

**Time:**

10 Min. State goals and relevance of the session. Trainees divide into two groups to work on the different brooding systems with a trainer facilitating each group.

20 Min. Trainees work on the brooding units adjusting heat sources, providing feed and water, placing wood shaving on floor, weighing feed and chicks and recording that information on charts.

20 Min. Alternate groups to observe what the other group has done. A discussion is faciliated on the advantages and disadvantages of each system, and the appropriateness for where they are going.

10 Min. Convene in large group. Review the responsibilities for caring for the animals and ask trainees to critique the one hour session.

**Materials:**

- .Baby chicks
- .Demonstration unit on farm
- .Battery brooder/kerosine lantern
- .Metal hover/light bulb
- .Feeders, waterers
- .Feed and scales
- .Record charts
- .Livestock guidelines
- .Practical Poultry Raising Manual

**Trainer Notes:** This must be one of the first session in order for trainees to observe a six (6) weeks growth process. These chicks will also be needed for other sessions such as vaccination and slaughter when they are older. Broiler chicks should be obtained because of their rapid growth rates.

Two trainers should facilitate this session. Different methods of raising chicks which may be more appropriate can be used instead of the method mentioned.

Trainees should prepare for this session by reading the required material. This session should be lengthened especially if some of the required equipment, such as waterers, etc, has not been purchased or contructed. If possible, a construction session can be incorporated into this session.

## CONSTRUCTION

**Time:** 2 hrs. (In barn)

**Goals:**

1. To provide needed equipment for the animal barn (feeders, waterers, pens, laying nests, roosts etc).
2. To learn how to construct the above mentioned equipment using local materials and resources.
3. To learn how to work together in small groups on tasks and practice possible skill transference.

**Overview:** Based on reading assigned before the session, trainees become familiar with different designs of equipment. Trainer also becomes familiar with the construction skills of those in the group. When trainees are broken into small groups to construct equipment, those trainees with little or no experience are placed with those who have more. Trainers should avoid teaching construction skills and allow the process of skill transference to occur among the trainees.

**Activities:**

| Time: | |
|---|---|
| 10 Min. | State goals and relevance of the session. |
| 15 Min. | Lists group tasks that are necessary and others that the trainees might want to. Facilitate the formation of small groups with a mix of experienced and less experienced trainers within each group. |
| 80 Min. | Trainees within their groups work on tasks. Possible tasks may be pen construction, feeder and/or waterer construction, laying nests, hovers, etc. |
| 15 Min. | Observe and critique equipment built and solicit feedback on skill transference. The importance of skill transference when dealing with farmers is emphasized. |

**Materials:**

.Saws
.Nails
.Hammers
.Wood
.Chicken wire
.Practical Poultry Raising Manual

Trainer Notes: If the possibility rises where a group has little or no construction experience, the lesson plan will probably have to be altered.

Very little purchasing of construction supplies should be done, so trainees will make use of scraps that may be around the training site. This encourages the trainee to consider the situations she/he will face overseas, either lack of resources or those that are expensive for the small farmers.

## HANDLING AND CULLING OF CHICKENS AND CARING FOR BROODY HENS

**Time:** 1 hr. (In barn)

**Goals:**

1. To learn proper methods of catching and holding chickens.
2. To become more comfortable working with the animals.
3. To become knowledgeable about the egg laying indicators by handling and observing laying and non-laying chickens.
4. To become more familiar with the characteristics and the care of broody hens.

**Overview:** This session is performed with three trainers operating three similar but different field sessions. One is handling and observing egg laying chickens, another is handling and observing non-laying chickens, and the last is handling and observing broody hens. All these sessions run simultaneously with three groups of trainees rotating every 15 minutes. In order that trainees become more familiar and comfortable handling chickens, this skill is repeated at every session.

**Activities:**

**Time:**

10 Min. State goals and relevance of the session. Divide trainees into three groups to work at different stations with trainers.

15 Min. **Egg laying station.** Trainer demonstrates how to catch and hold a chicken. Trainees practice this skill. Trainers show the egg laying characteristics (bright red comb, bleached beak, shanks, expanded bones, etc.), and trainees observe these traits being displayed.

15 Min. **Non-egg laying station.** Trainer demonstrates how to catch and hold a chicken. Trainees practice this skill. Trainer shows the non-egg laying characteristics (dull shrivelled comb, yellow shanks, closed bones, etc.), and trainees observe these traits being displayed.

15 Min. **Broody hen station.** Trainer demonstrates how to catch and hold a chicken. Trainees practice this skill. Trainees observe characteristics of a broody hen (sitting on eggs,

defensiveness cackling, etc.). Trainer demonstrates how to prepare a broody pen (dusting with pesticide, placing bird on egg, etc.).

5 Min. Critique the one hour session with the whole group of trainees and staff.

Materials:
- .Livestock Guidelines
- .Practical Poultry Raising Manual
- .Demonstration Unit on Farm with laying, non-laying, and broody hens.

Trainer Notes: Trainees should prepare for this session by reading the required material. They should also be encouraged to practice handling the birds during their free time.

Different skills can be incorporated or substituted in the session (e.g. feather clipping, treating for lice, debeaking, etc.).

One trainer can handle all three stations if the number of trainees is less than seven.

## VACCINATION FOR NEWCASTLE DISEASE

Time: 1 hr. (In barn)

Goals:

1. To demonstrate to trainees how to properly administer newcastle vaccine, via the drinking water method, to nine day old chicks.
2. To introduce the concepts of method demonstration and peer teaching experientially.

Overview: This session demonstrates one method of vaccinating poultry and gives the opportunity for a few trainees to volunteer, prepare and present a field session. Before the session the trainer facilitates the preparation for the session with the lead trainees and makes sure all required equipment and information is available. Trainees then demonstrate how to vaccinate the chicks to other trainees.

Activities:

| Time: | |
|---|---|
| 5 Min. | Trainees leading groups will complete the following:<br>.State goal number one and the relevance of the session. |
| 15 Min. | One group leader introduces the safety precautions in using a live vaccine and some background information of the disease. |
| 15 Min. | In a step by step manner another group leader shows how to properly store, open, mix, and administer the vaccine in the drinking water. |
| 15 Min. | Vaccine is administerd by volunteer in the group. Unused vaccine and vials are properly disposed. |
| 15 Min. | Group discusses appropriatness of vaccination in villages, possible problems they may encounter overseas with vaccination (e.g. expired or unavailable vaccine, poor quality, inappropriate doses for small farmers, lack of refrigeration, etc.). |
| 5 Min. | Ask group to critique session. |

Materials:
- .Newcastle vaccine with directions
- .Chicks
- .Livestock Guidelines
- .Non-chlorinated water
- .Powdered milk
- .Measuring cup
- .Waterers

Trainer Notes: Before the session, trainer will have to help plan the session with the group leaders in advance of the scheduled session.

This class can be introduced before there are formal classes on method demonstration or peer teaching. This will encourage and prepare trainees for future sessions that they will lead.

This same format can be used for other methods of vaccination.

## FEEDS AND NUTRITION

**Time:** 2 hrs. Classroom Session

**Goals:**

1. To learn how to calculate their own poultry ration.
2. To become familiar with the nutritional values and deficiencies of different feed ingredients.
3. To utilize and develop problem solving skills through trial and error and resource finding/utilization.

**Overview:** This session shows trainees how to utilize feed tables, nutritional requirements, and sample rations in order to to calculate their own assigned poultry ration. In doing this exercise, trainees learn about the values of different feed ingredients and how to balance these ingredients in order to satisfy the minimum nutrient requirements of poultry. They will also learn that nutritional requirements are based on age, production purpose, and type of fowl.

**Activities:**

**Time:**

5 Min. State goals and relevance of the session.

30 Min. Ask trainees if they understand the assigned reading, and review material as may be requested by trainees.

15 Min. Trainer does a portion of a ration on the board allowing trainees to assist.

10 Min. Lists requirements for the poultry ration problem that each trainee must calculate (e.g., each trainee hand in their own ration, minimum of five ingredients etc, choose their own fowl ration etc).

60 Min. Trainees are allowed to start calculating ration in class. This allows trainer and/or training assistant, to help trainees with any difficulty. The assigned ration is due the following week.

**Materials:**

.Livestock Guidelines
.Practical Poultry Raising
.Calculators, scratch paper

**Trainer Notes:** Emphasize to trainees that before any skill or proficiency is developed in calculating a ration, the trainees must use the trial and error method to determine how much of an ingredient(s) can be used to satify the nutritional requirement(s).

The largest difficulty trainees may have is performing basic math skills. When demonstrating examples on blackboard, trainer should consider this possibility when this situation arises. Trainer should encourage those who have no problems with math to help those who do.

Emphasize to trainees that the difficulty of the assignment is to provide trainees time to practice calculations and become more familiar with various possible feed ingredients.

# FOWL POX VACCINATION

**Time:** 1 hr.

**Goal:** To be able to vaccinate a chicken for Fowl Pox by the wing web stab method using a live vaccine.

**Overview:** This is a field exercise. It includes a discussion on Fowl Pox Disease, a demonstration by the trainer on proper methods of handling vaccine, application, disposal, preparing the chicken pen for vaccination, and vaccinating for Fowl Pox.

Each trainee practices vaccinating for Fowl Pox using a live vaccine via the wing web stab method. The remaining time is used to discuss the problems in vaccinating within the developmental frame work.

**Activities:**

**Time:**

| | |
|---|---|
| 5 Min. | State goal and conduct a method demonstration of proper handling, mixture, application, and disposal of vaccine. |
| 30 Min. | Trainees, working as a team, prepare the pen and flock for vaccination. Trainees take turns vaccinating, catching, and holding birds, each assisting each other. After vaccination, they re-arrange the pen, dispose of the unused vaccine, and record the event on the pen record chart. |
| 10 Min. | Discuss the prevention, control, transmission, and symptoms of Fowl Pox diseases. |
| 15 Min. | Facilitate a discussion on potential problems with vaccination in Third World Countries. Topics include lack of vaccine or refrigeration on hold vaccine, cost, unused expired vaccine, and vaccine produced and marketed for large poultry operations. Trainer relates possible problems with vaccination as an "inappropriate technology" to Extension Session Approaches to Development. |

**Materials:**

- .Flock of 3-6 week chickens
- .Fowl Pox vaccine directions
- .Wing stab applicator
- .Device to keep vaccine cold
- .Dr. Salsbury Manual on Poultry Diseases
- .Guidelines
- .Vaccine

## POULTRY DISEASES

**Time:** 2 hrs.

**Goal:** To understand the causes, transmission, symptoms, prevention and control of major poultry diseases.

**Overview:** This is a classroom exercise. The first half hour will deal with disease in general, different agents that cause disease, and how disease is spread. The next half hour will deal with the control of disease, different types of immunity, and how vaccines work. The last hour deals with specific diseases that affect poultry.

**Activities:**

**Time:**

| | |
|---|---|
| 30 Min. | Trainees brainstorm and discuss different diseases they are familiar with, which are contagious, and how (if treatable) they are treated. What diseases might they see overseas that we do not see in the US? A discussion follows on the different types of pathogenic agents which cause disease. |
| 30 Min. | Trainees discuss disease that they have been vaccinated for or will be once they are overseas. Discussion leads to how vaccines work, different types of a immunity, and different methods of administering vaccine.<br>Trainer makes a bridge between this session and the Extension Sessions on Health. |
| 60 Min. | Trainees compare similarities of poultry diseases, listed in poultry guidelines, with human diseases, types of vaccine used, etc.<br>Trainer conducts role play(s) in which trainees practice explanation of animal disease and control to rural villagers. |

**Materials:**
.Clasroom, board and chalk
.Dr. Salsbury Manual of Poultry Diseases
.Poultry Guidelines, pp. 26-36

## COMPARATIVE FOWL RAISING

| | |
|---|---|
| Time: | 1 hr. |
| Goal: | To apply knowledge and experience about poultry raising during training to different but similiar animals. |
| Overview: | This is a classroom exercise. The trainees summarize what they have learned about poultry raising in terms of breeds, nutrition, disease, and housing. They then discuss different but similar animals (ducks and guinea fowl). They compare the similarities and dissimilarities in raising these animals, make some generalizations, and then apply what they know to a somewhat different situation. |

Activities:

| Time: | |
|---|---|
| 20 Min. | Trainees in three small groups review what they already know about poultry breeding, nutrition, disease and housing, and each group prepares a short written summary. The groups report out to the large groups for questions, additions, and clarifications by other trainees and the trainer. |
| 20 Min. | Ask trainees what they know about ducks and guinea fowl. Trainees brainstorm and reflect on possible similarities between raising ducks and guinea fowl and raising chickens.<br>Trainer lists similarities and differences. Clarification is followed by discussion on similarities. |
| 20 Min. | Trainer leads a discussion on comparative learning in animal raising. Trainees discuss, brainstorm, and apply new knowledge to different hypothetical situations. (See Trainer Note). |

Materials:

- .Blackboard, chalk, classroom
- .Raising Ducks, USDA Publication
- .Raising Guinea Fowl, USDA Publication
- .Guidelines on ducks and guinea fowl.

Trainer Note: The point might be made that learning by analogy is an important skill for the development worker in all areas, not just in technical matters.

## PRODUCTION PLANNING

**Time:** 2 hrs.

**Goals:**

1. To plan a poultry project using inputs such as feed consumed per bird, cost of eggs, feed to gain ratio, and average percent production. This is for a moderate level production project.
2. To understand what inputs may not be appropriate for a survival level project and what provisions may be appropriate for the small scale farmer.

**Overview:** This is a classroom problem solving exercise summarizing information obtained in the field. The trainees review the records they have kept on a flock of birds they have been raising. On their laying flock they determine feed consumed, eggs produced, cost of producing a dozen eggs, and if any profit was made. Then they compare these figures with those recommended in their poultry guidelines and evaluate their project. A discussion will follow on the appropriateness of expensive inputs such as balanced feeds, exotic breeds, etc.

**Activities:**

| Time: | |
|---|---|
| 10 Min. | State goals. |
| 15 Min. | Trainees review records they have kept on a flock of layers determining total feed consumption and egg production. |
| 30 Min. | Trainees determine average percent production, feed consumed per bird, cost to produce a dozen eggs, feed conversion ratio, profit/loss. |
| 15 Min. | Trainees compare their figures with those from the poultry guidelines which lists feed comsumption, egg production, feed to dozen eggs. Differences are discussed, reasons why, and how to improve their management practices. |
| 30 Min. | Conduct a discussion on whether the input used on their project will be available or affordable for small scale farmer. Topic for discussion is: high tech-high cost agriculture packages a suitable tool for rural development? |

20 Min. Discuss how appropriate technology can be applied to small scale village poultry projects. Trainees analyze a case study and #R30.

Materials:

- .Flock of laying birds
- .Pen with feeders, waterers, nests, etc.
- .Feeds
- .Record keeping system telling number of birds, feed given, eggs produced
- .Guidelines

## SLAUGHTER/POST MORTEM

**Time:** 2 hrs.

**Goal:** To slaughter and dress a chicken and examine the organs of the animal for possible parasites and disease symptoms.

**Overview:** This is a field exercise. It includes a half hour of demonstration by staff on how to slaughter and do a post mortem on a chicken. For the next hour the trainees divide into groups to work on their own chickens. The session ends with a half hour discussion on the application of what they did.

**Activities:**

| Time: | |
|---|---|
| 5 Min. | State goals and relate to training design. |
| 25 Min. | Trainer silently demonstrates slaughter, dress and post mortem on a chicken while trainees observe technique. |
| 90 Min. | Trainees in groups of four recap the steps followed by the trainer. |

**Materials:**

.Birds
.Razor blades, knifes
.Buckets and hot water
.Dr. Salsbury Manual on Poultry Diseases, Basic Poultry Diagnostic Guide from Guidelines

**Trainer Notes:** Although trainees cannot make disease diagnosis, they can detect worms and they can infer that a disease is contagious if several birds show the same post mortem conditions.

Trainer may point out that the credibility gained through these skills can be useful in entering a new community.

By slaughtering and dressing a chicken, the trainees can compare how meat is processed in a village setting to how they easily purchase what they want to eat in a US supermarket.

Trainees can relate their possible sensitivity to animals (pets vs. food source) to enable other people to view the purpose of animals and their use.

## INTRODUCTION and OVERVIEW

Time: 2 hrs.

Goals:

1. To familiarize trainees with the methods of handling, catching, restraining, and throwing goats and present an outline of the daily care needed by goats.
2. To build the trainee's confidence in handling large animals and familiarize the trainees with the daily care of animals (i.e. that animals need care, not 5 days, but 7 days a week).

Overview: The first hour will be spend in the field. There should be at least 1 goat per 4 trainees. Each trainees will practice catching and throwing a goat. Enough trainers should be present so that 4 trainees can work at a time. After everyone has practiced sufficiently the group will discuss the purpose of being able to properly handle goats. Then the trainer will assist the group in listing out the trainees' responsibilities for the daily care of the goats.

The second hour will be spent in class. The trainees will be asked to identify the purpose of goats in the U.S., Third World, and their host country. They will then be asked to give characteristics of low and high level production and rate the P.C. training project with goats at one of these levels. This will lead into a discussion of the 5 components of livestock production and the need to balance each of these to the same level of production for greatest returns.

Activities:

Time:

10 Min. Trainer introduces the class and goals.

35 Min. The group should divide up into subgroups of 3 to 4 each, with 1 goat on hand for each group. The trainer demonstrates the steps in catching, restraining, and throwing the goat. Then the trainees all try it at least once with the trainers present to assist. (The important thing for the trainer is to step back, relax, and let the trainees try--even if they fail the first time.)

15 Min. Trainer begins a discussion in which trainees identify the care needs of the goats (both daily and occasional). Trainees list the tasks to be done and then make for their completion. (The trainer pays attention to the work being included on the list, allowing trainees to decide what is to be done and making sure that everyone understands their responsibilities.) The list would normally include feeding, watering, milking, etc.

15 Min. Trainees list on the blackboard the various purposes of goats in the U.S., Third World, and their host country. The staff works to generate discussion, include all points of view, discuss their similarities and differences, and clarify any obvious misconceptions.

20 Min. The trainees will characterize survival, moderate, and high level operations in their host country. The trainer questions the group and clarifies when necessary. Trainer asks questions such as: "What is high investment?", "What is moderate investment?", and "What is survival?"

The P.C. training goats project is rated by the group as low, moderate, or high production and reasons will be discussed for the choice.

15 Min. The trainees and staff will mention the 5 components of livestock production, reminding the trainees that this concept has already been introduced in an earlier session. The trainer asks questions to generate discussion, such as:

-"What characteristics have we looked at above in evaluating each production level?"

-"What are the most important, most limiting, and most expensive feed ingredients?"

-"Why do humans and animals complete for food, oftentimes, in the Third World?"

-"Is it always best to use native stock for projects?"

-"What should you do before starting a project if your village has major morbidity or mortality diseases?"

10 Min. The group discusses the 5 components and their interaction in each of the high, moderate, and survival levels of production.

Questions to ask:

-"How does each component effect the other?"

-"How does poor nutrition start a chain reaction of problems?"

-"Why should all 5 of these components balance at the same level?"

Materials:

.Goats, rope, and pens
.Blackboard and chalk
.Guideline material
.PTR trip
.Other L.S. classes (introduction and overviews)

## ANATOMY and CASTRATION

**Time:** 2 hrs.

**Goals:**

1. To castrate at least 2 bucks with a knife. To emphasize the purpose of goats as meat producers, not pets. To learn one credibility technique which, with practice, they can use as PCV's.
2. To discuss advantages, disadvantages, and acceptability of castration by host country farmers.
3. To familiarize the trainees with the most important parts of the goats and their functions.
4. To estimate the weight and age of goats. To give to trainees comparisons of age and weight and relate that to the nutrition of the animal.
5. To give trainees an idea of what anatomical parts to look at in the selection of goats.
6. To make comparisons of age and weight and relate that to the nutrition of the animal and estimate the weight of an animal in order to use medicines in the proper doses.

**Overview:** This will be a field exercise with 4 goats, 2 does and 2 bucks. The trainees will be divided into 2 groups and each group will work with one doe and one buck. Anatomy parts to be included: Head, poll, horns, scent glands, wattles, teeth, heartgirth, barrel, hip bones, pin bones, triangle, udder, hock, dew claws, hovers, testicles, and vulva. The second part of the exercise will be using tape measures and a weight chart to estimate the weight of each goat. The third part will be examing the teeth of the 4 goats to estimate the age of each. The fourth part will be a discussion on the differences nutrition can make in the weight and size of an animal.

Next the group will divide into two subgroups and take one buck each. Each group will then castrate one buck. After this has been completed, the purpose of the castration and the conditions under which it is a recommended practice will be discussed. The discussion will take place in the barn and will involve the trainer working to establish a dialog with the trainees through questioning.

Activities:

Time:

5 Min. Trainer introduces the class and goals.

5 Min. Trainees divide into 2 groups and each group takes two goats and prepares them for examination by putting on a rope halter and tying them up.

15 Min. Trainees handle and examine the goats as the trainer discusses anatomical terminology and points out important things to look for when selecting a goat. Trainer mentions:

-Heartgirth, used to measure weight;

-Head, whether or not it has horns (not an indication of sex, could have been dehorned); and

-Teeth, an explanation of how they are used to determine age.

10 Min. Each group measures the heartgirth of a goat to determine its weight. (Points to remember are):

1. Use a tape measure that reads in inches;
2. Measure the heartgirth and read off the inches;
3. Record the measurement in your field notebook;
4. Look on the chart for the corresponding weight; and
5. Discussion with the group about the valuable nature of the information when determining proper doses of medication.

15 Min. Each group examines the teeth of a goat to estimate its age. (Points to be included are):

1. The teeth give an idea of age only up to 5 years.
2. Kids have 8 small teeth. Yearlings have 2 large front teeth and 6 small teeth, 2 year olds have 4 large front teeth and 4 small teeth, 3 year olds have 6 large front teeth and 2 small teeth, 4 year olds have 8 large teeth. After 4 years teeth tend to spread out, become worn, and start to drop out.

10 Min. The group reunites to discuss its conclusions on nutritional effect on weight at different ages. The trainer will relate this dialog to probable conditions to be found in their host country.

25 Min. The group will divide into 2 smaller groups and 2 trainees will restrain the buck while 2 more perform the castration under the close guidance of a trainer. The following steps will be performed:

1. Restraint - the buck will be thrown and tied;
2. The scrotum sack will be sterilized with alcohol or iodine;
3. The lower part of the scrotum will be cut off with a knife;
4. Each testicle will then be cut into and squeezed til it pops out of the scrotum;
5. The membrane and sperm duct will be cut.
6. The blood vessel will be scraped and pulled until it snaps;
7. Another trainee will repeat the procedure on the other testicle;
8. A wound spray or disinfectant will be applied to the wound.

10 Min. The trainer then calls on various trainees and asks them to express the emotions that they felt while the animal was being castrated. The trainer then asks if others had similar feelings. Once the full range of felt emotions have been presented the trainer asks all of the group to examine their own values that led to the emotional response and to compare them with what they think a future counterpart might feel in the same situation. The end result (hopefully) is better understanding for the trainees of their values and the values their future counterparts may have concerning animals. (See Trainer Note).

25 Min. The trainer will then discuss the circumstances calling for castration, other methods of castrating, advantages, disadvantages, acceptance, and the use as a credibility technique by PCV's.

Why is castration done? Enforced selective breeding, taste and tenderness of meat (cultural taste), and manageability of the buck. Other possible methods of castration: Elastrator and Emasculator. The need for specialized equipment will be discussed, the age at which to castrate, and host country castration techniques.

Materials:

- .4 goats, 2 bucks and 2 does (of different ages and nutritional levels)
- .Ropes for restraining the bucks
- .A sharp knife
- .Alcohol, iodine, or other disinfectant
- .Tape measure
- .Weight chart for goats
- .Dairy Goats - Breeding/Feeding/Management - Anatomy diagram

Trainer Note: Dealing with ambivalence regarding castration can be linked to cultural adaptation issues.

## CONSTRUCTION

Time: 4 hrs.

Goals:

1. To examine and define the needs of the goat facilities at the training center and build whatever is necessary, using locally available materials.
2. To learn to recognize needs when evaluating a goat operation.
3. To rectify faults through construction of "equipment" using whatever tools and materials are available.

Overview:

This will be a field session. The first part of it will be a discussion among the group deciding what is faulty or missing that can be built or improved upon in this goat facility. Then the group decides what can be built to rectify the problems. Possible examples are hay racks, feeders, waterers, salt boxes, gates, and fences. The second part of the session will be the actual construction of these things. It is improbable that the entire project can be completed in 4 hours normally and therefore the group may need to devote some free time to its completion.

Activities:

| Time: | |
|---|---|
| 5 Min. | Trainer introduces the class and the goals. |
| 25 Min. | Trainees examine any problems that have occured with the goats or the pens. They decide on what action to take to rectify the problem. This will iclude a discussion of the needs, why they are needs, prioritize them, and decide what can be built. |
| 60 Min. | The group draws up a list of the materials needed for the construction and a design of what is to be built. They set out to scrounge and purchase the needed materials, recycling what is available locally and making it as realistic as possible with regard to conditions in-country. |
| 150 Min. | Trainees build the project, those with carpentry skills assisting those with less skill. |

Materials:

- .Saws
- .Hammers
- .Nails
- .Tape measures
- .Square
- .Wood
- .Wire
- .Wire cutters, etc. (This list will vary depending on what is to be built and what is available locally.)
- .The other livestock construction classes
- .The Peace Corps Livestock training barn.

Trainer Note: The trainer should assist the trainees but do not dominate or do the work yourself.

## REPRODUCTION

**Time:** 1 hr.

**Goals:**

1. To describe to the trainees the reproductive cycle of goats (lactation, heat cycle, breeding season, and sexual maturity).
2. To describe the 4 signs of approaching kidding and 4 practices to be done immediately after kidding.
3. To familiarize trainees with normal reproduction in goats and to discuss possible problems due to survival level management typically found in the host country.
4. To emphasize the interaction of nutrition, disease, genetics, housing, and management and show that goat raising is a complex operation.

**Overview:** This is a classroom session. First, the importance of reproduction will be discussed and the typical reproductive cycle of a goat will be drawn out. Then the specifics of heat, gestation, and kidding will be discussed with reference to signs and procedures. Failure of reproduction will then be discussed, with emphasis on the production framework (i.e., climate, nutrition, disease, reproductive disorders, and age).

**Activities:**

**Time:**

5 Min. Trainer introduces the class, goals, and guidelines material.

25 Min. Trainer provides a visual representation (blackboard or handout) of a "typical" reproductive cycle of a doe. Trainer asks trainees to draw analogies to the human reproductive system and cycle. Points to be included are: Laccation (length, frequency, abnormalities, diseases), estrus (signs, duration, breeding dates, ovulation), gestation (stages of growth, duration, nutritional), and finally, kidding (signs, colostrum, preparation, and procedures).

30 Min. Based on the information that has already been exchanged, the trainer draws the group into a dialogue on the procedures followed immediately after kidding, as well as rebreeding. If time still allows, try to get a quick discussion of possible factors effecting reproduction (i.e. nutrition, disease, age, and breed). The trainer should provide a detailed description of all parts of the reproductive cycle and the causes and effects of reproductive failures.

**Materials:**

.Blackboard and chalk
.Other livestock classes on reproduction
.Dairy Goats by the American Dairy Goat Association
.Improvement of Livestock Production in the Tropics, McDowell

## RUMINANT NUTRITION

Time: 2 hrs.

Goals:

1. To define what a ruminant is, study its digestive system, and discuss how these affect its dietary requirements.
2. To identify some advantages of ruminants in developing countries.
3. To introduce some concepts of nutrition and feeds for future work in balancing feed rations.

Overview: This is a classroom session. The first part will be discussing the difference between ruminants and monogastrics, and giving examples of animals for each. Next, the functions of each of the four ruminant stomach compartments will be presented. The process of ruminant digestion will be discussed when talking about the rumen, and this leads to a discussion on quality of proteins, roughages, and vitamins in the diet of the ruminants. How a feed analysis is done will also be briefly outlined so that feed tables can be understood and used. Some definitions and characteristics of roughages will also be treated.

Activities:

| Time: | |
|---|---|
| 5 Min. | The trainer introduces the topic and goals. |
| 20 Min. | The trainer illustrates on the blackboard or with a handout a monogastric and a ruminant digestive system. (If there is a fistulated cow available, use it instead.) The trainer then leads the group into a diaglogue on the similarities and differences in the two system. Points to be included in this discussion are: Examples of ruminants (cows, goats, sheep) and examples of monogastrics (man, poultry, pigs), the 4 "stomach" compartments, bacteria, and nutrients. |
| 30 Min. | Trainer shows the parts of the ruminant stomach system to the trainees. (Preferably, the trainees should remove and examine the digestive system in a post mortem examination of a goat. If that is not possible, then it should be illustrated by the trainer). Each organ should be examined in detail and any abnormalities pointed out. The group should become familiar with function and appearance of the reticulum, rumen, omasum, and abomasum. |

10 Min. Break

25 Min. Trainer discusses the nutritional vs. dietary requirements of goats. The trainer should explain the process of using the special enzymes produced by bacteria for digestion of cellulose, lignin, starches, and sugars to the group. Points also to be covered include: Protein quality (examples of high quality such as meat, moderate such as legume seeds, and low such as corn), roughages, vitamins, volatile fatty acids, and the use of nitrogen in synthesizing amino acids.

15 Min. Trainer discusses the purpose of conducting a feed analysis and how it can be used. Points to be included in the discussion are: Storage, feeding standards, and tables (CP, DP, TDN, ME, CF, and DM), forages, silage vs. hay, concentrates, digestability, fats, calorie content, processing, percentage of protein, and minerals. Ultimately, the trainee should have a better understanding of ruminant nutrition and an appreciation for its complexity.

15 Min. Finally, the trainer closes the session with a discussion of roughages and how they form the main part of a goat's diet. The economic implications of this in their host country should be touched upon. Also to be discussed are the use of legumes as roughages (i.e., alfalfa, clover, cowpeas, beans, soy, peanuts, etc.) and characteristics to look for in a forage crop (green coloring, leafiness, age, harvesting and storage conditions).

Materials:

.Blackboard and chalk
.Either a fistulated cow, a diagram of a ruminant digestive system, or the complete anatomical digestive system of a ruminant.
.Handout on tropical feeds and their nutritional values.
.Feeds and Feeding by Morrison
.Improvement of Livestock Production by McDowell
.Goats, Feeding/Breeding/Management American Dairy Goat Association

## RATIONS and FORAGES

**Time:** 2 hrs.

**Goals:**

1. To balance 2 goat rations using the NRC requirements and discuss forages of the tropics and pasture management.
2. To familiarize trainees with supplementing goats, if their forage is of poor quality and an improvement in production is desired.
3. To discuss the importance of pasture mangement, problems with forages, and some possible solutions.

**Overview:** This will be a classroom session. After the topic is introduced, there should be a discussion on tropical forages and pasture management. Following this discussion the trainer demonstrates how to balance a feed ration. The rest of the session is used by the trainees to individually balance 1 feed ration each.

**Activities:**

| Time: | |
|---|---|
| 5 Min. | Trainer introduces the topic and goals. |
| 30 Min. | Trainer conducts a discussion on tropical forages and pasture management. Points to be included in the discussion are: Silage, "new crops" (acacia, stylo, leucaena, and sorghum), grasses, legumes, and the effects of overgrazing and drought on tropical pastures. Trainees brainstorm possible solutions or ideas in regard to the obvious problems of mismanagement, poor yields, stocking rates, and improved pastures. |
| 20 Min. | Using 1 ration that the trainer previously balanced using feedstuffs available in the host country for high level production, and the assigned percentages, trainees use their calculators to make the mathematical calculations needed to assign nutrient values to each feedstuff. (One trainee can then record the values on the blackboard.) The process continues until the ration has been balanced. |
| 5 Min. | Break |

60 Min. Each trainee balances a feed ration using the same process that the trainer used. The ration should meet the following criteria:

-Balanced for a high production level

-Contain at least 4 different feed ingredients commonly found in the host country. Different grasses and legume crops should be included.

-Within 10% of the NRC requirements for goats. The 4 values to be balanced should include total digestive nutrients, digestable protein, calcium, and phosphorus.

Materials:

.Blackboard and chalk
.Calculators
.NRC tables on nutritional requirements for goats
.Feeds and Nutrition by Ensminger
.Improvement of Livestock Production in the Tropics, McDowell
.The Host Country Ag. Environment Class
.All other Livestock classes on nutrition and feeds
.One balanced feed ration for goats

Trainer Notes:

1. If the trainer can find time in the schedule it may be a good idea, depending on local feeds and management, to include a class on the actual making of silage.

2. Ideally, the trainer should have a handout prepared on tropical forages and pasture managment for the group to read before class. Failing that, the material could be lectured on as a second choice. The material will be new to most, but the trainer should still make an effort to draw on what the group already knows.

3. Take the time to elaborate on each step in the process so that everyone is clear on what is happening. Math skills may be weak, so go slow and be patient.

4. The trainer should have support from 1 or 2 other trainers (all armed with calculators) to be present and answer questions as they arise during the last hour. Trainers should answer questions individually and not have the group meet as a whole during this hour.

## INTERNAL and EXTERNAL PARASITES and VITAMIN SHOTS

**Time:** 2 hrs.

**Goals:**

1. To deworm a goat and give one vitamin A and D shot intramuscularly.
2. To understand other forms of parasite control by understanding life cycles and conditions under which parasites thrive.
3. To learn how parasites are controlled in the U.S., how they may be controlled, at low cost, in third world countries, how serious parasite infestations can be, and how this effects production of livestock.

**Overview:** Following the opening introduction to the class and goals the group will move to the barn where the trainer will demonstrate the proper method of giving a vitamin shot and deworming one goat. Then the group will repeat the shot and deworming. As many trainees will repeat the procedure as is possible given the number of goats available. Then the group will return to the classroom where there will be a discussion of some life cycles and favorable conditions for various external and internal parasties as well as various control measures. During the field portion of this session (shots and deworming) some background information on detection of parasites and chemical controls will be explained.

**Activities:**

**Time:**

5 Min. Trainer introduces the topic and goals.

15 Min. The trainer gives a method demonstration on giving a vitamin A and D shot to one goat. In doing so he or she should explain how the dosage was decided upon, how to properly use the syringe and vial, where to give the shot, how to give it, and things to be wary of. Possible side effects of the medication should be touched upon as well as its effect on the goat.

10 Min. Trainer continues the method demonstration on deworming the goat, explaining the procedures as in the first part of the demonstration.

60 Min. Trainees deworm and give the shots. (See Trainer Notes.)

30 Min. In the classroom, the trainer discusses prevention, diagnosis, and treatment of external and internal parasites. A more detailed explanation should also be given for the vitamin shot. Points to be inlcuded are: Parasite life cycles, effects of heat and humidity, types of parasites (ticks, lice, grubs, round worms, and coccidiosis), vectors, chemical controls, manual controls, and the effect of all this on the host. (See Trainer Notes.)

Materials:

.Vitamin A and D, injectable (50cc)
.Disposible syringes, needles (#18 or 20, 1.5")
.Alcohol and cotton balls
.TBZ or other worming boluses
.Worming, balling gun
.Malathion 5% dust for external parasite control
.Gloves
.Sulfaquinoxiline (for coccidiosis control)
.Samples or pictures of various parasites
.Goats to work on
.Extension class on Volunteer Health and Wellbeing
.Other Livestock Classes on parasites
.Merck Manual
.Manual Practico del Hacendado, Bayer
.Extra trainers to supervise the small groups

Trainer Notes: If you have a large group it is best to have more than one syringe and needle in order to speed up the work. Work closely with each trainee, praise their successes, and try to dispell the fear of the animal and the needle in their minds.

It would be ideal to have on hand physical examples of these different parasites. If not use photos and drawings. Present as much information as possible on specific medications available in country.

# DISEASES

Time: 2 hrs.

Goals:

1. To discuss the importance of animal health to livestock production, the difference between morbidity and mortality diseases, 5 specific goat diseases (their prevention, diagnosis, and treatment), and emphasize preventative, non-vaccine related measures.
2. To learn the differences between a healthy animal and a sick one and that curing with antibiotics or using a diagnostic lab may be appropriate in only a few circumstances.
3. To emphasize that morbidity diseases cause more losses in livestock production than mortality diseases.

Overview: The class will start with an introduction and then move to the barn where one trainee facilitator and as many trainees as possible will treat for mastitis. They will then return to the classroom to discuss the appropriateness of this practice in their host country. Then the trainer will dialog with the group on 5 other specific diseases (their prevention, diagnosis, and treatment) and what each means in terms of the PCV working in the host country as a developmental worker.

Activities:

Time:

5 Min. Trainer introduces the class and goals.

45 Min. In the barn, the trainee facilitator treats one goat for mastitis after pointing out the symptoms to the group. The trainee facilitator goes slowly, step by step, through the procedure and allows time for questions. Then the trainees repeat the procedure on other goats with mastitis.

10 Min. When the mastitis treatment is completed and before returning to the classroom the trainee facilitator should draw the group into a discussion on the "appropriateness" of this procedure in their host country. Points to be considered in this dialog are:

-How widespread is mastitis in the host country?

-Are vaccines available to treat it?

-Are detection kits available?

-What impact has it had on production? Prices?

-Is there a government quarantine policy?

-What are the goals of the farmer?

-If the medications are available, are they too expensive to use?

10 Min. Trainee-facilitator solicits feedback from the group on his or her presentation and facilitation skills.

50 Min. 5 other goat diseases will now be discussed in regards to prevention, treatment, and diagnosis. These 5 will vary from country to country but they might include: Foot and Mouth Disease, brucellosis, tuberculosis, East coast fever, and redwater fever. It is important here that the trainer have the material well read before starting this portion of the class since, probably, the trainees have very little knowledge concerning these diseases and the trainers will be viewed as the "experts". This material can be taught through lecture but it is better to use handouts and a dialog approach.

**Materials:**

.Slides or pictures showing symptoms of diseases discussed
.Tube of mastitis cure
.Blackboard and chalk
.Several does with mastitis
.The Merck *Manual*
.*Improvement of Livestock Production in the Tropics*, McDowell
.*Diseases in Cattle*, Am. Vet. Publications, Inc.
.Other livestock classes on diseases
.*Where There Is No Doctor*

**Trainer Notes:** Have extra trainers on hand to work with the smaller groups that form in order to treat the other does. Trainers can also assist the trainee-facilitator in responding to questions.

## PRODUCTION PLANNING

**Time:** 4 hrs.

**Goals:**

1. To analyze a situation after outlining the guidelines for doing so (considering factors of infrastructure, marketing, culture, available feeds, technical support, short and long range impact).
2. To realize possible problems and results of starting goat projects without fully analyzing an actual situation.

**Overview:** The material to be covered in the class is introduced. There is a discussion of what guidelines can be followed by a PCV to help him or her analyze the feasibility of starting a goat project. Following a break, a scenario describing a host country farmer with goats at a low level management similar to the one attached is distributed and analyzed.

**Activities:**

**Time:**

10 Min. Trainer introduces the class, the topic, and the goals.

70 Min. Trainees brainstorm guidelines for analysis. Trainer emphasizes the guidelines as a tool for the group to use when evaluating a management situation to see if change is possible for the local farmer. This framework includes the following points:

1. Nutrition

   What's locally available? What is the nutritional value of each feed? Possible problems (storage, rainy season, insect attack, pilferage). Cost of the feed? Available year round?

2. Diseases/Parasites

   Morbidity vs. Mortality, availability of lab work, vaccines, vets, etc. The cost of different services. Government quarantine.

3. **Housing**

   Will it improve situation? Shortcomings? Cost? Availability? The extra labor, time, and management involved vs. free range. Availability for water.

4. **Management**

   Local practices. The cost of the proposed change to the farmer. Receptivity to change. Current levels of management. Effects on the culture by changing management levels.

5. **Genetics**

   Common--for survival or low level production. Improved for moderate production (low survivability). Cross--Better production, decreased survivability.

6. Possible recommendations based on analysis: Credibility techniques; low cost, easily understood practices; lessening dependency on the PCV and outside resources.

10 Min. Break.

50 Min. The trainer distributes 3 scenarios to the trainees for them to read. Small groups brainstorm and using the analysis guidelines, answer the questions listed with each scenario.

**Materials:**

.Blackboard and chalk
.The livestock guidelines
.Three prewritten scenarios of different levels of production
.The developmental framework continuum
.P.T.R. trip information
.Other Livestock and Extension classes on management planning

**Trainer Notes:** The trainer should work only to ask questions and not answer them. Draw upon all the trainees have learned in the training to answer to questions. Remind them that livestock production is complex with no simple or one way answers. Continue to point out the complexities of each situation and the dominance of nutrition in animal health. Spend approximately 50 minutes on each scenario.

# CHAPTER III: GUIDELINES AND REFERENCES

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# SMALL ANIMAL PRODUCTION

## Training Objectives

### A) Livestock Development

| Class | Checkoff |
|---|---|
|  |  |
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1. List the 5 components of livestock development.
2. List 5 examples (1 from each of the 5 components) that make an operation to be:
    - A. Low production
    - B. Moderate production
    - C. High production
3. Evaluate 3 livestock operations to determine the level of production and make management recommendations based on local conditions and resources
4. Participate in all scheduled field trips to local farms.
5. Describe the major steps of the research - extension chain.
6. Describe the major climatic zones, rainfall and cropping patterns, infrastructure, planting and harvest dates of forage crops, and common management practices for animals in your host country.
7. Give 2 method demos on a live stock technique or practice in accordance with guidelines from the staff.
8. Hand mix at least 1 feed ration.
9. Maintain a field notebook.

## B) Poultry Production

| Class | Checkoff | |
|---|---|---|
| | | 1. Brood, feed, and care for a batch of 50 day old chicks on a rotating basis throughout training. |
| | | 2. Feed, water, and care for the layers and broilers. |
| | | 3. Contrast improved and traditional poultry raising practices and discuss their pros and cons. |
| | | 4. Give broiler and layer production goals feasible for the small scale farmer. |
| | | 5. Compare the major pros and cons of cage vs. floor housing under local conditions. |
| | | 6. Give temperature guidelines for brooding and 3 methods suitable for the small scale farmer. |
| | | 7. Distinguish between sick and healthy birds. |
| | | 8. Participate in the construction of waterers, feeders, brooders, and shelters. |
| | | 9. Vaccinate the flock for New-castle, Fowl Pox, and Bronchitis. |
| | | 10. Define coccidiosis, describe the symptoms, and list 2 control measures. |
| | | 11. Give the nutritional requirements of poultry and balance at least 1 feed ration. |
| | | 12. Cull laying hens to separate good producers from poor producers. |
| | | 13. List 3 ways to control cannibalism. |
| | | 14. List 4 management guidelines for minimizing disease. |

## C) Ducks and Guinea Fowl Production

| Class | Checkoff |
|---|---|
| | |
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| | |
| | |
| | |

1. Feed, water, and care for the ducks and guineas during training on a daily rotating basis.
2. Compare different breeds of ducks and their purpose in regard to meat and egg production.
3. Contrast and compare duck management in regards to rearing, feeding, and disease control.
4. Define and discuss major duck diseases, their prevention, and control.
5. Identify major advantages in raising ducks compared to other fowl.
6. Identify advantages of raising guinea fowl vs. other fowl.
7. Compare management practices for guinea fowl with other types of fowl.

## D) Swine Production

| Class | Checkoff |
|---|---|
| | |
| | |
| | |

1. Feed and care for an about to farrow sow and a litter of weaned feeder pigs during training on a daily rotating basis.
2. Contrast traditional and improved methods of swine raising and discuss their pros and cons in terms of cost returns.
3. Give feasible production goals for the small scale farmer.

| Class | Checkoff | |
|---|---|---|
| | | 4. Describe the reproductive period of swine as to: heat cycle, estrus, gestation period, heat symptoms, lactation, signs of farrowing, and post-weaning heat. |
| | | 5. Assist a sow at farrowing. |
| | | 6. Give guidelines for and perform the following operations: clip needle teeth, tail dock, and give iron shots to newly born piglets. |
| | | 7. Participate in the construction of a farrowing crate and explain its advantages. |
| | | 8. Distinguish between sick and healthy pigs. |
| | | 9. Disinfect one hog shed and list one readily available disinfectant in your host country. |
| | | 10. Discuss the nutritional requirements of pigs and balance 1 feed ration. |
| | | 11. Treat for 2 common internal parasites of swine and discuss their prevention, diagnosis, and treatment. |
| | | 12. Treat for 2 common external parasites of swine using a recommended insecticide for their control. |
| | | 13. List 3 major swine diseases, discuss their symptoms, prevention, and treatment. |
| | | 14. Design a management plan and operation schedule for a 2 sow operation. Include inputs, costs, and estimated returns. |
| | | 15. Administer medications and deworming medicines as required. |

| Class | Checkoff | |
|---|---|---|
| | | 16. Keep production records on the training swine project and use them to determine profit or loss and the level of production. |
| | | 17. Describe swine anatomy in relation to animal production. Give guidelines on swine selection and discuss methods of herd improvement feasible for small scale farmers. |

E) Goat Production

| Class | Checkoff | |
|---|---|---|
| | | 1. Feed, water, and care for goats daily on a rotating basis. |
| | | 2. Describe major parts of the anatomy of a goat and explain the function of each. |
| | | 3. Describe the reproductive cycle of the goat including sexual maturity, estrus, signs of estrus, breeding day, breeding season, lactation length, and gestation length. |
| | | 4. List 3 signs of the approach of kidding and give 3 recommended practices to be done at and after kidding. |
| | | 5. Balance 1 feed ration from locally available feeds for medium and high production level goat operations. |
| | | 6. Identify 3 vitamin and nutrient deficiencies in goats and give recommendations as to how to correct and prevent them. |
| | | 7. Give 2 intramuscular and 1 subcutaneous injection. |
| | | 8. Trim hooves of goats. |

| Class | Checkoff | |
|---|---|---|
| | | 9. Make a simple rope halter for leading and restraining. |
| | | 10. Administer worming medication and coccidiosis control medications to 2 goats. |
| | | 11. Recommend, prepare, and administer proper doses of medicines and vaccines for goats. |
| | | 12. Distinguish between a sick and healthy goat. |
| | | 13. Identify and treat 3 major diseases of goats. List the causal agent, symptoms, and control measure for each. |
| | | 14. Milk a doe by hand and keep milk weight records throughout the training. |
| | | 15. Evaluate a proposed project considering such factors as infrastructure, marketing, site, culture, price of available feeds, water supply, technical support, and short and long term impact. |

## F) Rabbit Production

| Class | Checkoff | |
|---|---|---|
| | | 1. Feed, water, and care for at least 3 about-to-kindle does during training on a rotating daily basis. |
| | | 2. Feed, water, and care for a group of weaned fryers. |
| | | 3. Give feasible production goals for small rabbit raising and the pros and cons of rabbit produc- |
| | | 4. Distinguish between sick and healthy rabbits. |

| Class | Checkoff | |
|---|---|---|
| | | 5. Determine pregnancy in a doe by palpation; accurately determine the sex of rabbits over 8 weeks of age. Hold a rabbit correctly. |
| | | 6. Participate in the construction of housing, feeders and waterers. |
| | | 7. Give the nutritional requirements of rabbits. Balance at least one feed ration for rabbits. |
| | | 8. Describe the reproductive cycle of rabbits. |
| | | 9. Diagnose ear mites and apply the necessary treatment. Treat for mange and conjuctivitis. |
| | | 10. Treat for coccidiosis, describe the symptoms, and give the methods of control. List 4 management guidelines for minimizing diseases. |
| | | 11. Butcher and dress out a rabbit following the instructor's guidelines. Participate in at least 1 postmortem exercise. |
| | | 12. Ear tatoo at least one rabbit. |
| | | 13. Determine the feed to grain ratio for the rabbits in our project and do a cost/analysis of the projects based on local market conditions. |
| | | 14. Keep precise breeding, feed consumption, and reproduction records for the project. Keep a field notebook in accordance with the guidelines from the staff. |

## OVERVIEW OF LIVESTOCK TRAINING

Livestock training is designed to establish a basis for making the management decisions called for in the development of livestock operations. Because there are no absolutes in animal husbandry, our first goal is for you to learn that in a complex system based on locally available resources there are very few instant technological innovations that are truly effective. For this reason, the training is developed within a framework or continuum of development reaching from high tech. production levels to the free range survival level. Within this developmental continuum, training focuses on the five principal categories of livestock development: 1) Nutrition, 2) Management, 3) Diseases & Parasites, 4) Genetics, and 5) Housing. Most emphasis is placed on nutrition, the beginning and end of all livestock operations. (75% to 90% of the cost of raising animals can be feed). The health of the herd and the profit or loss for the farmer are all directly controlled by the nutrition and feeding of the animals. Nutrition is the most limiting factor in livestock development and therefore is the area that volunteers must develop before changing breeding stock or management levels.

The training manual/guidelines take the approach that in order to develop a profitable livestock operation all five of the categories must be balanced on the same level of the continuum. This balancing point on the developmental continuum is determined by a host of factors including markets, pricing of feeds and meat, local infrastructure, water quality, cultural tastes in meat, credit, agricultural extension, government policies, management levels, diseases, vaccines, medications, parasites, and locally grown animal feeds.

Therefore, when development workers learn the mechanics of a given technique (such as debeaking of chickens), they also must consider the context in which the practice will be employed. To determine the appropriateness of a given practice or technique, you should constantly ask:

- Is this practice consistent with local management levels and resources?
- What are the potential risks for the farmer?
- Will it increase profit?
- Are the risks for potential loss too great to justify the potential gain?
- What long term effects will it have on the livestock operation?

The training manual/guidelines provide an integrated approach to technical information and ability as well as the developmental worker skills. The lesson plans reflect integration of these skills through an experiential training methodology implemented through intensive, "hands-on" learning. Sixty percent of the technical time is spent working with the animals and 40% in the classroom. The trainees are responsible for the daily feeding, watering, and caring for the animals.

## The Role of the Development Worker in Small Animal Projects

Successful animal projects (e.g. ones that make money for the farmer) are projects in which the five components of animal raising (breeds, nutrition, disease, management, and housing) either match or balance in the level of development and production.

The Chart below explains this concept.

### High Management vs. Low Management on the Development Continuum

| Animal Raising Component | High Level Production | Low Level Production |
|---|---|---|
| 1. BREEDS | Animals genetically selected for efficient production of meat, eggs, milk: exotic, hybrid breeds | Animal naturally selected for survivability e.g. "survival of the fittest"--selection for agressiveness through exposure to predators: Native/Country Chickens |
| 2. NUTRITION | Animals fed a well balanced, scientifically determined feed in order to reach genetic potential | Animals fed scraps and/or scavenge for food on their own; a well balanced diet not always assured, less meat and eggs, slow growth |
| 3. DISEASE | Prevention due to a high degree of sanitation, isolation, quarantine, use of vaccines and antibiotics for treatment | Prevention due to animals that survive a disease outbreak over a period of time a natural resistance is developed. Survivors become hardier and more resistant to pathogens |
| 4. MANAGEMENT | Animals receive considerable amount of supervision/care, e.g., constant availability of water, feed. Recordkeeping | Animals care for themselves with minimum care from owner. They develop survival characteristics |
| 5. HOUSING | Confinement, controlled environment, light, temperature, ventilation | Free range or partial shelter usually exposed to the elements |
| 6. DEGREE OF INVESTMENT | High with optimum returns if all components/production factor controlled | Low investment, low return, animals are not bred and raised for production purposes |

## Why Some Animal Projects Fail

The degree of success of any animal project must have all the components match; that is, you cannot have one component in a low level of production while the rest of the components are in high levels of production.

Example:

A project has a supply of exotic breeds, a sophisticated disease control program, good housing, and management. Unfortuately there is not a good source of nutritious feed in the area. This project will fail because the nutrition component does not match the other components. The animals will never reach their genetic potential because of a poor diet. And this poor diet will stress the animals to such a point that disease would eventually become a problem. Nutrition is usually the most limiting factor in animal projects. No matter what the genetic sophistication of the animal is, the animal must have the proper diet for its production purpose.

On the other side of the spectrum, if a project consists of using well balanced feed on native/country animals, it would probably fail also. Although a well balanced feed would be better than table scraps, the native animal does not have the genetic potential to produce meat, eggs, milk, etc. to make cost of the feed justifiable. In other words, the animal cannot utilize the feed efficiently.

The examples mentioned are typical situations and reasons why development projects fail in developing countries. Planners either fail to look at the project in terms of the component package where all five components must be at the same levels or they feel that any one of the components (because it originates from a developed country) is better than none at all.

## Advantages of Country/Native Breeds

A good example of the latter situation is when exotic breeds of chickens are introduced into a village setting. Here the village breed has the advantage over the hybrid, especially if the village has no vaccines available or hatcheries to incubate eggs artifically. The exotic breeds have no natural resistance to disease in the area. Their aggressiveness has been bred out, so if they are free ranged, they are at the mercy of predators. And, if these hybrids have been selected for egg laying, broodiness has been bred out. Broodiness is the instinctive behavior chickens exhibit when they stop laying and sit and hatch their eggs.

The chances of these exotic breeds to survive are minimal. They will either be killed by disease or predators, or fail to reproduce offspring. It is important for the development worker to realize that improved scientific systems are not always appropriate for some situations.

## The Development Worker Skills

The extension/development worker must be able to determine, assess, and evaluate the systems of animal raising and production that he/she will find somewhere between the high level production system and the low level or survival level of production system. This ability or skill does not necessarily arise from having a technical background in animal raising. Information which can be readily available from a government office or library in the developed world may not be so accessible in a village in Africa. Skills in communications, information gathering and filtering, and community entry will be needed by the development worker in order for him/her to assess the local situation, evaluate resources and determine management systems in a particular area.

This can be a very slow and patience developing process. It can also be an enjoyable way of learning about a new place, its people and culture. Once these skills are utilized, only then can the development/extension worker determine if change that is desired by the farmer is appropriate and can be implemented successfully.

## Credibility Techniques

The Practical Poultry Raising Manual (ICE M-11) describes this (see page 16) as determining the gap and trying to fill it. The gap is what is between the production potential and the present situation. Once it has been determined that change is possible and appropriate, it is best to introduce it in small increments, especially those most easily understood by the farmer and those which show the quickest results and cost the least. These increments of change are sometimes called credibility techniques, because if done correctly, they help build confidence between the development worker and the farmer. With this confidence, larger increments of appropriate change can be introduced. The farmer can gradually have more control over his production components and move his management system on the development continuum towards an improved system, appropriate for his needs and desires.

# INTRODUCTION TO ANIMAL NUTRITION

The basic concepts defined and discussed in this section of the livestock guidelines are also applicable to human nutrition. In the spirit of training integration it is a hope that these guidelines help the trainees develop a deeper understanding of their own nutritional needs by learning about those of animals. Furthermore, many of these concepts can be applied to those people they will be working with in-country. Many of the ideas and concepts covered in this section relate to the topics of health and nutrition in core classes and nutrition in the crops/vegetable training.

Nutrition is the process of changing food to living tissues and maintaining it. Nutrients are substances that:

1. Build and repair body tissue
2. Provide energy
3. Regulate body processes.

The amount of these needed in the body depends on:

1. The species of the animal i.e. simple stomach vs. ruminants
2. Purpose of the animal:

    a. Egg, meat, milk, or wool production
    b. Lactation/reproduction
    c. Growth
    d. Maintenance

Many microorganisms have simple nutrient requirements. They are:

a. Inorganic elements
b. Water
c. Source of nitrogen
d. Source of energy

All these can provide growth and production. Higher animals, including man, require more complex nutrient needs. Simple stomach or monogastric animals (man, chickens, and pigs) unlike ruminant animals (cows, sheep, and goats) require more complete proteins and vitamins in their diet because they cannot produce protein that includes all of the essential amino acids with just a supply of nitrogen.

Nutrients can be divided into six categories. These are water, carbohydrates, fats, proteins, vitamins, and minerals.

## I. Water

Water is the cheapest and most abundant nutrient. Consider the following:

1. 65 to 70% of the body weight at birth is water.
2. 40 to 50% of body weight of an animal at marketing is water.
3. 90 to 95% of the blood is water.

Sources of water to the animal include:

1. Drinking;
2. Food;
3. Metabolism (break down of nutrients).

If water is not available or withheld from an animal, the animal compensates in order to produce enough water to maintain its body's normal functioning. First, urine excretion and water in the feces are reduced. Second, the animal metabolizes the tissues present to provide metabolic water, causing weight loss. Third. the animal attempts to keep cool seeking shade so as to reduce water loss from evaporation and sweating. Fourth, there is a reduction in feed consumption unless the feed is high in moisture. In low production or survival environments, the animals have probably developed these compensatory mechanisms as a means of survival. Since their owners do not usually provide water, the animals probably have developed a resistance to drought stresses and through time have become hardier animals.

Factors which affect the water requriement:

1. The type of diet, i.e., green forage vs. dry forage
2. The purpose of the animal, i.e., lactation vs. meat
3. The type of digestive tract, i.e., ruminant vs. nonruminant
4. The type of urinary system, i.e., mammals vs. birds

Function of water in the animal:

1. Transport of nutrients
2. Chemical reactions
3. Temperature regulation
4. Maintains shape of the body cells
5. Lubricates and cushions the body

Approximate water consumption (mature animal)

1. Swine 1 1/2 to 3 gallons/head/day
2. Sheep 1 to 3 gallons/head/day
3. Poultry 2 parts water for each part of dry feed

## II. Carbohydrates (CHO) Energy nutrient

1. These are made up of carbon, hydrogen, and oxygen with chemical similarity of $H_2O$.
2. These include sugars, starches, and cellulose.
3. Very little occurs as such in the animal's body.
4. CHO makes up 3/4 of plant dry weight.
5. It forms the largest part of an animal's food supply.
6. These are formed by photosynthesis in plants.

Classification (by number of sugar molecules)

1. Monosaccharides (simple sugars)
    - a. Glucose
    - b. Fructose
    - c. Galactose

2. Disaccharides

   a. Sucrose
   b. Malatose
   c. Lactose

3. Polysaccharides

   a. Starch. Stored in small amounts in the body in the form of glycogen in the liver.

   b. Cellulose. All walls of plant cells are composed of cellulose.

Digestibility

Crude fiber (cellulose, hemicellulose, & lignin) poorly digested CHO.
Nitrogen Free Extract (soluble sugars and starches) readily digested.
Function:

1. Energy;
2. Heat;
3. Building stones for other nutrients;
4. Stored in animal's body by converting into fats.

III. Fats - Lipids (either extract)

1. Made up of CHO

2. Produces approximately 2.25 times more energy than CHO or proteins, and more per unit of weight.

3. Composition: Fat = Glycerol and 3 fatty acids.

4. Fatty acids are either saturated or unsaturated.

5. Fatty acids considered essential for animals:

   a. Oleic
   b. Linoleic
   c. Linolenic
   d. Arachidonic

6. Fats are located in the animal body just below the skin surrounding the internal organs, in the milk, and marbling. In plants, fats are found in the seed germ or embryo.

7. Function:

   a. Energy
   b. Heat and insulation
   c. Protection
   d. Aid in absorption of fat soluble vitamins
   e. Marbling

## Measuring the energy value:

Although all nutrients are equally important, feedstuffs are usually evaluated on the energy value because:

1. Energy is required in larger amounts than other nutrients.
2. It is the most limiting factor in livestock production and the major cost.
3. When all the other nutrients are present in adequate amounts, the amount of feed consumed is determined primarily by the energy level of the ration.

Energy is usually measured in kilocalories (Kcal). A Kcal is the amount of energy as heat required to raise the temperature of 1 kilogram of water one degree Centigrade. Another system of measuring energy is the Total Digestible Nutrient system (TDN). This system is usually used in determining the energy requirements of ruminants and rabbits. TDN is the sum of the digestible protein, fiber, nitrogen free extract (CHO), and fat X 2.25. It is expressed either as a percentage of a ration or in pounds or kilograms.

The following scheme explains the utilization of energy by the animal:

Gross Energy

Digestible energy
(Similar to TDN)

Fecal Energy

Metabolizable
Energy

Urinary/Combustible
energy Gas

Heat Increment

Net Energy

Maintenance

Production

Gross Energy is the total potential energy of the feedstuff.

Fecal Energy is energy lost in the form of undigested food residue and energy-yielding metabolic products.

Digestible Energy is GE - FE, Energy received by digestion - similar to TDN.

Gaseous products of digestion = energy lost by combustible gases which escape the body.

Urinary Energy is energy lost in the urine during intermediary metabolism.

Metabolizable Energy is the usual portion of the ingested energy. DE - UE = ME The ME value of feeds is usually used when determining the energy requirements for pigs and chickens. Usually it is a more accurate measure of energy available for the animal.

Heat Increment or HI is the increase in heat after the animal consumes feed.

Net Energy NE = ME - HI. The amount of energy used for maintenance and/or production.

## IV. Protein

1. Composed of carbon, hydrogen, oxygen, nitrogen, and sometimes phosphorus and sulfur.
2. Protein contains approximately 16% nitrogen so: $\frac{\%\ N}{16\%}$ = Crude Protein = %N x 6.25
3. Protein consists of many molecules of amino acids (AA) joined by peptide linkages, i.e., $AA_1 - AA_2 - AA_3 - - AA_x$

### Types of Protein

1. True protein: that which is composed of only amino acids.
2. Nonprotein Nitrogen (NPN): compounds which are not true protein in nature but contain N and can be converted to protein by bacterial action.
3. Crude protein: that protein which is composed of true protein and any other nitrogeneous product. % N x 6.25 = Crude Protein
4. Digestible protein: that portion of the crude protein which the animal can digest.
5. Essential amino acids: those amino acids which are essential to the animal and are needed in the diet because the animal's body cannot synthesize them fast enough to meet its requirement. Some of the most limiting amino acids (most difficult to supply in the diet) are: Lysine, Methionine, and Tryptophane.

Non-essential amino acids: those amino acids which are not needed in the diet but are still essential for the animal.

### Measure of Protein

Protein quality refers to the amount and ratio of the essential amino acids.

Measures Used:

1. Biological value (BV): A measure of the relationship of protein retention to protein absorption; or the % of true absorbed protein that is utilized for maintenance and/or production. A protein with a BV of 70 or more (70% of the intake of N is retained) is considered capable of supporting growth if the caloric value of the diet is adequate. If less than 70%, the protein is less capable of supporting life.

| Examples of measurement: | Biological value |
|---|---|
| a. Whole egg protein | 100% |
| b. Meat protein | 72 - 79% |
| c. Cereal protein | 50 - 65% |

2. Net protein utilization (NPU) is a measure of protein quality expressing both the digestibility of the protein and the BV of the amino acid mixture absorbed from the intestine. NPU = BV x digestibility.

Barrel Concept explaining limiting amino acids: See illustration I-1.

In order to understand the concept of limiting amino acids, the barrel concept is most helpful. Consider the barrel as the structure which holds amino acids together, like peptide bands, and each stave of the barrel is an amino acid (essential or non-essential). Consider the barrel's purpose, holding water, as a special protein which, let us say, makes muscle. The amino acid and the amount of water the barrel will hold (to continue the analogy, muscle that will be made) is limited to the amount of lysine available. In the drawing, methionine is the next most limiting AA. The lengths of the other staves (amino acids) above the length of the lysine stave will not be used for holding water or making muscle. The nitrogen portion of these amino acids will be passed in the urine and the C, H, & O will be utilized as energy. This is a very inefficient method of suppling energy needs because:

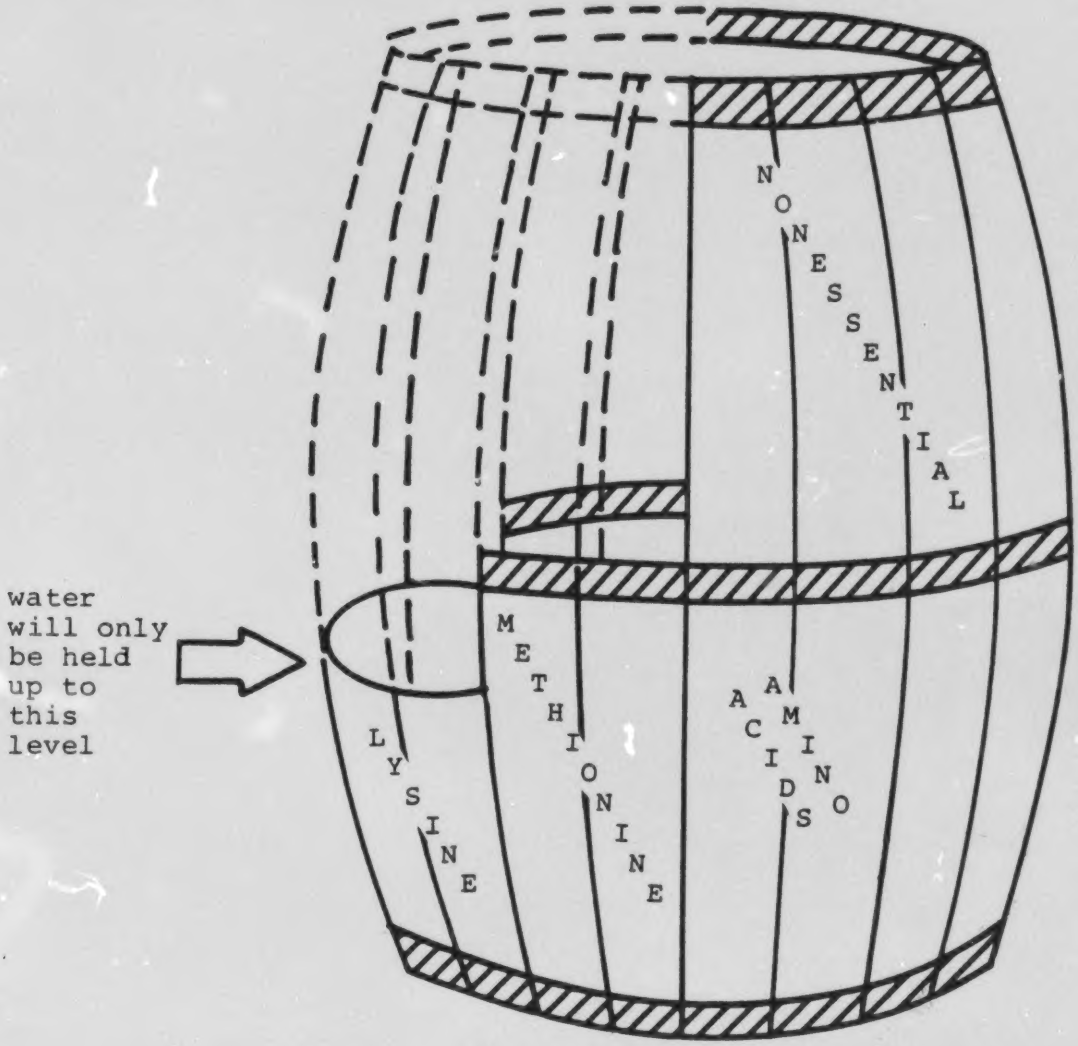
1. Protein, per unit of weight, is usually more expensive than carbohydrates.

2. The breaking down of protein to provide energy is stressful to the animal's system.

If a protein is not supplying all the essential amino acids in the right proportions at the critical time for growth and development, then the protein is not considered complete. Eggs and meats are usually considered complete proteins. No single plant protein is complete, but soybeans and peanuts come close.

Complementary proteins: When a complete protein is not available, different feed ingredients can be combined which can provide a more complete protein. Examples of supplementary action between different proteins would be beef blood meal, which is low in isoleucine and high in lysine and tryptophan, and corn gluten meal, which is high in isoleucine and low in

## BARREL CONCEPT
## CHART


water will only be held up to this level
NONESSENTIAL
AMINO ACIDS
METHIONINE
LYSINE

LYSINE is the most limiting.

METHIONINE is the second most limiting.

Lysine determines how much water the barrel will hold, or muscle that will be made.

lysine and tryptophan. When combined in a ration 1 part BBM to 4 parts of CGM, the mixture provides all three amino acids in considerable amounts to promote growth.

The second example would involve soybean and sesame meal. Soybeans are high in lysine but low in methionine. Sesame is low in lysine but high in methionine. These two, when combined, provide a more complete protein.

Examples of complementary foods can be seen in food mixtures throughout the world: Rice and beans, rice and lentils, and tahini (chickpeas and sesame paste).

Purpose/Function of Protein

1. Essential for growing cells

    a. Maintenance
    b. Production, i.e., eggs, meat, milk, and wool
    c. Reproduction

2. Included in the structure of:

    a. Enzymes
    b. Hormones
    c. Catalyst
    d. Antibodies

3. May be used for energy.

V. Minerals (See Tables 1-1)

1. Inorganic elements

2. The total mineral content of plants or animals is called ash.

Classification

1. Major minerals: Calcium, phosphorus, Sodium, and Chlorine.

2. Trace minerals: Iodine, Potassium, magnesium, manganese, sulfur, iron, zinc, copper, cobalt, and molybdenum.

3. Flourine and Selenium are considered beneficial in small amounts but toxic if in excess.

General Function

1. Skeletal formation and maintenance.

2. Constituent of nucleoproteins which are vital to all cellular activity.

3. Oxygen transport.

4. Chemical reaction in the body.
5. Fluid balance (osmotic pressure and excretions).
6. Regulates acid-base balance.
7. Help in enzyme system.
8. Mineral - vitamins relationship.

## VI. Vitamins

1. Organic in nature; 2. Dietary requirements of one or more species; 3. Necessary in small amounts; 4. Effective for metabolic activity but are not found in the structure portion of the body.

Types:

1. Fat soluble (ADEK); 2. Water soluble (Thiamine, riboflavin, niacin, pantothenic acid, pyridoxine, biotin, choline, folic acid, & $B_{12}$; 3. Inositol, paraamino-benzoic acid (PABA), and Vitamin C.

## Table 1-1
## Animal Mineral Chart

| Mineral | Major Function | Some Deficiency Symptoms | Major Interrelationships; Toxicities | Good Sources for Animals | Comments |
|---|---|---|---|---|---|
| Major or macro minerals: | | | | | |
| Sodium (Na) | Major cation in osmotic pressure and acid-base balance in body fluids, upon which depends the transfer of nutrients to the cells and the removal of waste materials and the maintenance of water balance among the tissues.<br>Associated with muscle contraction.<br>Important in making bile. | Reduced growth and efficiency of feed utilization in growing animals, reduced milk production and weight loss in adults.<br>Lowered reproduction (infertility in males, and delayed sexual maturity in females).<br>Craving for sodium, evidenced by such things as drinking urine.<br>In laying hens, a deficiency of sodium results in lowered production, loss of weight, and cannibalism. | Salt toxicity, which is accentuated with restriction of water intake, readily occurs in nonruminants. It is characterized by a staggering gait; blindness, and other nervous disorders.<br>Excess Na results in hypertension. | Salt; free-choice, or added to the ration at a level of 0.25–0.50%. | The body contains approximately 0.2% sodium. |
| Chlorine (Cl) | Major anion involved in osmotic pressure and acid-base balance (chloride shift).<br>Chief anion of gastric juice where it unites with H ions to form hydrochloric acid. | Depressed growth rate.<br>Chicks on Cl-deficient diet exhibit nervous symptoms induced by sudden noise. | Excess Cl is not likely. | Salt; free-choice, or added to the ration at a level of 0.25–0.50%. | In practice, Na and Cl are supplied together as common salt.<br>The body's requirement for Cl is approximately half that of Na |
| Calcium (Ca) | Bone and teeth formation; nerve function; muscle contraction; blood coagulation; cell permeability.<br>Essential for milk production and for formation of eggshell in poultry. | Rickets in young.<br>Osteomalacia in adults.<br>Tetany (hypocalcemia). Milk fever in dairy cows is the classical example of Ca tetany.<br>*Hens:* Thin-shelled eggs, drop in egg production, and lowered hatchability. | Calcium-phosphorus ratio is important. For nonruminants, it should be 1:1–2:1. For ruminants, it may be anywhere from 1:1–7:1.<br>Vitamin D is involved. If adequate vitamin D is present, the ratio of calcium to phosphorus is less important.<br>Excess Ca reduces the absorption and utilization of Zn. In swine, this causes parakeratosis.<br>Excess Mg decreases Ca absorption, replaces Ca in the bone, and increases Ca excretion. | Oystershells.<br>Limestone.<br>Dicalcium phosphate.<br>Defluorinated phosphate.<br>Protein supplements of animal origin, legume forages, and rape.<br>Milk.<br>Bone meal. | Over 70% of the ash of the body consists of Ca and P.<br>Approximately 99% of the Ca of the body is present in the bones and teeth.<br>Calcium availability of 70% is generally assumed for all feedstuffs. |

*(Continued)*

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Table 1-1
Animal Mineral Chart
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| Mineral | Major Function | Some Deficiency Symptoms | Major Interrelationships; Toxicities | Good Sources for Animals | Comments |
|---|---|---|---|---|---|
| Phosphorus (P) | Bone and teeth formation; a component of phospholipids which are important in lipid transport and metabolism and cell-membrane structure.<br>In energy metabolism.<br>A component of RNA and DNA, the vital cellular constituents required for protein synthesis.<br>A constituent of several enzyme systems. | Rickets in young.<br>Osteomalacia in adults.<br>Depraved appetite (pica), but this is not specific for phosphorus deficiency.<br>Breeding problems.<br>Urinary problems.<br>*Hens:* Reduced egg production. | Ratio of Ca-P is important; somewhere between 1–2 parts of Ca to 1 part of P.<br>Sufficient vitamin D is necessary for P assimilation and utilization.<br>Excess Ca and Mg cause decrease in P absorption.<br>In ruminants, excess P in relation to Ca is likely to cause calculi. | Monosodium phosphate.<br>Diammonium phosphate.<br>Dicalcium phosphate.<br>Defluorinated phosphate.<br>Bone meal.<br>Most cereal grains and their by-products (notably wheat bran) are high in P. | Approximately 80% of the P of the body is present in the bones and teeth.<br>Excess P may result in lameness and spontaneous fracture of long bones.<br>High P has a laxative effect. |
| **Magnesium (Mg)** | Essential for normal skeletal development, as a constituent of bone; enzyme activator, primarily in glycolytic system.<br>Helps to decrease tissue irritability. | Vasodilation, with resulting reduction in blood pressure (manifested outwardly by a flushing of the skin).<br>Hyperirritability.<br>Tetany (grass tetany, or grass staggers) characterized by loss of appetite, (anorexia), hyperemia, convulsions, and death. | Excess of Mg upsets Ca and P metabolism.<br>Mg toxicity from feeding has not been demonstrated. | Magnesium sulfate or oxide, mixed with salt or small amount of feed. | Deficiencies of Mg may be encountered with suckling calves and pigs. |
| Potassium (K) | Major cation of intracellular fluid where it is involved in osmotic pressure and acid-base balance.<br>Muscle activity.<br>Required in enzyme reaction involving creatine.<br>Influences carbohydrate metabolism. | Growth retardation, unsteady gait, general muscle weakness, pica, diarrhea, distended abdomen, emaciation followed by death.<br>Abnormal electrocardiograms. | Magnesium deficiency results in failure to retain potassium; hence, it may lead to K deficiency.<br>Excessive levels of potassium interfere with magnesium absorption. | Potassium chloride.<br>Roughages usually contain ample potassium. | Potassium deficiency may occur in drylot finishing cattle or sheep on a high-concentrate ration. |
| Sulfur (S) | Required as a component of sulfur-containing amino acids cystine and methionine.<br>As a component of biotin, sulfur is important in lipid metabolism.<br>As a component of thiamin, it is important in carbohydrate metabolism.<br>As a component of coenzyme A, it is important in energy metabolism. | Retarded growth, primarily due to not meeting the sulfur amino acid requirement for protein synthesis.<br>Sheep fed nonprotein N to replace protein without S supplementation show reduced wool growth (wool contains approximately 4% sulfur). | Sulfur is related to the amino acids cystine and methionine, and to biotin, thiamin, and coenzyme A (see column to left, "Major Functions").<br>Sulfur toxicity is not a practical problem. | Nonruminants should be provided sulfur-containing proteins.<br>Ruminants and horses may be provided sulfur in protein, as elemental sulfur or as sulfate sulfur. | The body contains approximately 0.15% sulfur.<br>Sulfur requirements are primarily those involving amino acid nutrition.<br>Ruminants fed urea as a source of protein nitrogen may benefit from supplemental sulfur. |

*(Continued)*

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Table 1-1
Animal Mineral Chart
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| Mineral | Major Function | Some Deficiency Symptoms | Major Interrelationships; Toxicities | Good Sources for Animals | Comments |
|---|---|---|---|---|---|
| **Trace or micro minerals:** | | | | | |
| Chromium (Cr) | Insulinlike effect in glucose metabolism (shown in the rat). | | | There is no evidence that practical animal rations need to be supplemented with Cr. | The importance of Cr in glucose metabolism of other animals (other than the rat) and man has not been established to date. |
| Cobalt (Co) | As a component of vitamin $B_{12}$.<br>Rumen microorganisms use Co for the synthesis of vitamin $B_{12}$ and the growth of rumen bacteria. | Deficiency of Co in cattle and sheep produces symptoms similar to a deficiency of vitamin $B_{12}$.<br>Ruminants grazing in Co-deficient areas show loss of appetite, reduced growth, and loss in body weight, followed by emaciation, anemia, and eventually death. Frequently a depraved appetite is noted.<br>The disease called "salt sick" in Florida is due to Co deficiency associated with Cu deficiency.<br>In different parts of the world, Co deficiency is known as Denmark disease, coast disease, enzootic marasmus, bush sickness, wasting disease, Nakuritis, and pining disease. | Related to vitamin $B_{12}$.<br>Cobalt toxicity is not likely. | Cobaltized mineral mixture made by adding Co at rate of 0.2 oz/100 lb of salt as cobalt chloride, cobalt sulfate, cobalt oxide, or cobalt carbonate. Also, several good Co-containing commercial minerals are on the market.<br>Grazing animals may be given pellets composed of cobalt oxide and iron administered orally with a balling gun. The pellets lodge in the rumen and are gradually dissolved over a period of months. | The Co content of the leaves of the catalpa tree is regarded as a good indicator of the adequacy of cobalt in an area.<br>Co-deficient areas have been reported in Australia, western Canada, and in the U.S. in the states of Florida, Michigan, Wisconsin, Massachusetts, New Hampshire, Pennsylvania, and New York. |
| Copper (Cu) | Along with iron and vitamin $B_{12}$, copper is necessary for hemoglobin formation, although it forms no part of the hemoglobin molecule (or red blood cells).<br>Essential in enzyme systems, hair development and pigmentation, bone development, reproduction, and lactation. | Fading hair coat; light wool growth and straight, hairlike fibers, known as steely wool.<br>Nervous symptoms, known as ataxia.<br>Lameness, swelling of joints, and fragility of bones.<br>Nutritional anemia, commonly called "salt sick." | An excess of molybdenum in the presence of sulfate causes a condition which can be cured by administering copper.<br>Excess copper (levels above 250 ppm) is toxic; it accumulates in the liver, and death may result.<br>In high-molybdenum areas, the Cu level for horses and cattle should be about 5 times higher than normal. | Trace mineralized salt containing copper sulfate or copper carbonate.<br>Any mineral mix containing copper must be thoroughly mixed in order to prevent copper toxicity or poisoning. | A variable store of copper is located in the liver and spleen.<br>Milk is low in Cu; hence, young animals raised almost exclusively on milk may develop anemia.<br>The soils of Florida and the Coastal Plain region are copper deficient.<br>Copper deficiencies are common in Australia. |
| Fluorine (F) | Protects against dental caries (tooth decay) in children, and possibly in other animals, also. | Excesses of fluorine are of more concern than deficiencies in livestock production. | High dietary Ca depresses F uptake of bone.<br>F is a cumulative poison; hence, the toxic effects may not be noticed for some time.<br>High levels result in enlarged bones; softening, mottling, and irregular wear of the teeth; roughened hair coat; delayed maturity; and less efficient utilization of feed. | No need to supplement livestock with fluorine has been demonstrated. Should such supplementation be necessary, 1 ppm in the drinking water should suffice. | |

*(Continued)*

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Table 1-1
Animal Mineral Chart
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| Mineral | Major Function | Some Deficiency Symptoms | Major Interrelationships; Toxicities | Good Sources for Animals | Comments |
|---|---|---|---|---|---|
| Iodine (I) | Needed by the thyroid gland for making thyroxin, an iodine-containing hormone which controls the rate of body metabolism or heat production. | Goiter (big-neck) in humans, calves, lambs, and kids; stillbirths and weak young; hairless pigs; woolless lambs at birth.<br>There is no satisfactory treatment for animals that have developed pronounced I-deficiency symptoms.<br>Iodine deficiency in young animals is called cretinism. In adults it is known as myxedema. | Long-term chronic intake of large amounts of I reduces thyroid uptake of I.<br>Marked species differences exist in tolerance to high intakes of I. | Stabilized iodized salt containing 0.01% potassium iodide (0.0076% I).<br>Calcium iodate.<br>Ethylenediamine dihydriodide (EDDI). | Enlargement of the thyroid gland (goiter) is nature's way of trying to make enough thyroxin (an I-containing hormone) when there is insufficient I in the feed.<br>Mature animal body contains less than 0.00004% I.<br>I deficiencies are worldwide. In the U.S., the Northwest, the Pacific Coast, and the Great Lakes regions are goiter areas. |
| Iron (Fe) | Iron is a constituent of hemoglobin, the iron-containing compound that transports oxygen.<br>Also, iron plays a role in cellular oxidations, being a component of certain enzymes concerned with oxygen transfer. | Fe-deficiency anemia, characterized by smaller than normal number of red cells and less than normal amount of hemoglobin. | Iron is related to hemoglobin.<br>Cu is required for proper Fe metabolism.<br>Pyridoxine deficiency decreases the absorption of Fe.<br>Too much iron may be deleterious—interfering with phosphorus absorption by forming an insoluble phosphate. | Ferrous sulfate administered orally, or iron dextran injection.<br>Leafy portions of plants, meats, legume seeds, cereal grains, and cane molasses.<br>Trace mineralized salt. | The body contains only about 0.004% iron. Thus, a mature human contains only about 1/10 ounce of this mineral.<br>Iron is stored in the liver, spleen, and kidneys.<br>Young animals are born with a store of iron. But, milk is low in iron. So, when young animals are continued on milk for a long time, particularly under confined conditions and with little or no supplemental feed, nutritional anemia will likely develop. |
| Manganese (Mn) | Essential for normal bone formation (as a component of the organic matrix).<br>Thought to be an activator of enzyme systems involved in oxidative phosphorylation, amino acid metabolism, fatty acid synthesis, and cholesterol metabolism.<br>Growth and reproduction. | Poor growth.<br>Lameness, shortening and bowing of the legs, and enlarged joints.<br>"Knuckling over" in calves.<br>Impaired reproduction (testicular degeneration of males; defective ovulation of females).<br>Slipped tendons (perosis) in poultry. | Excess Ca and P decreases absorption.<br>Mn is not toxic in moderate excesses. | Trace mineralized salt containing 0.25% manganese (or more). | |

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Table 1-1
Animal Mineral Chart
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| Mineral | Major Function | Some Deficiency Symptoms | Major Interrelationships; Toxicities | Good Sources for Animals | Comments |
|---|---|---|---|---|---|
| Molybdenum (Mo) | As a component of the enzyme xanthine oxidase—especially important in poultry for uric acid formation.<br>Stimulates action of rumen organisms. | Toxic levels of Mo are of greater practical concern than deficiencies. | Mo is related to uric acid formation in poultry and microbial action in ruminants.<br>Mo as a toxic mineral affects cattle and sheep grazing pastures grown on soils high in Mo content.<br>Toxic levels of Mo interfere with copper metabolism; hence, increase copper requirements. | No Mo supplementation of normal rations is necessary. | Mo toxicity results in severe scours and loss of condition. |
| Selenium (Se) | Not completely known. But involved in vitamin E absorption and/or retention. Also, a required nutrient in its own right. Se prevents degeneration and fibrosis of the pancreas in chicks.<br>Implicated with glutathione peroxidase. | Nutritional muscular dystrophy in lambs and calves.<br>Exudative diathesis in poultry.<br>Liver necrosis in pigs. | Selenium is related to vitamin E absorption.<br>Animals consuming forage or grain produced on seleniferous soils develop blind staggers or alkali disease, characterized by emaciation, loss of hair, soreness and sloughing of hooves, lameness, anemia, excess salivation, grinding of the teeth, blindness, paralysis, and death.<br>In poultry, egg production and hatchability are reduced and deformities are common, including lack of eyes and deformed wings and feet. | High-protein rations tend to protect against Se toxicity. | In 1974, FDA approved the addition of Se in either sodium selenite or sodium selenate at rate of 0.1 ppm to complete rations for swine, growing chickens to 16 weeks of age, breeder hens producing hatching eggs, and nonfood animals; and at rate of 0.2 ppm in complete rations for turkeys. |
| Silicon (Si) | Involved in the mineralization process in bones. | | From a practical standpoint, adverse effects of high-Si intake rather than Si deficiency appear to be of concern.<br>Urinary calculi may develop upon excessive intake of silicon. | One of the most abundant elements on earth. Present in large amounts in soils and plants. | On purified diets, the addition of Si has increased the growth rate of chicks and rats. |
| Zinc (Zn) | Needed for bone and feather development.<br>Zinc is a component of several enzyme systems, including carbonic anhydrase.<br>Also, Zn is required for normal protein synthesis and metabolism. | Loss of appetite and stunted growth.<br>Poor hair or feather development; slipping of wool.<br>Rough and thickened skin in swine, known as parakeratosis. | Excess Ca reduces the absorption and utilization of Zn, precipitating parakeratosis in swine.<br>Excess Zn interferes with Cu metabolism and may cause anemia. | Zinc carbonate.<br>Zinc sulfate. | Zinc imparts "bloom" to the hair coat. |

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Table 1-2
Animal Vitamin Chart

| Name of Vitamin | Animals Most Affected | Functions | Some Deficiency Symptoms | Good Sources for Animals | Comments |
|---|---|---|---|---|---|
| **The fat-soluble vitamins:** | | | | | |
| Vitamin A | Affects all farm animals, including poultry. | Bone growth.<br>Night vision (formation of visual purple in the eye).<br>Epithelial tissue maintenance—respiratory, urogenital and digestive tracts, and the skin. | Stunted growth or loss of weight and loss of appetite, xerophthalmia (an eye disease), night blindness, nervous incoordination as shown by a staggering gait, and sterility in males and females or young which are born weak or dead.<br>Reproductive failure.<br>Hydroencephaly in young rabbits born to deficient females.<br>*Chicks:* Wobbly gait.<br>*Hens:* Reduced egg production and hatchability. | Vitamin A can be provided as the synthetic vitamin or as its precursor, carotene. Rich sources of carotene follow:<br>Green, leafy hays, not over 1 year old.<br>Grass silages.<br>Lush, green pastures.<br>Yellow corn.<br>Green and yellow peas.<br>Fish oils.<br>Carrots.<br>Whole milk.<br>Dehydrated alfalfa meal. | Vitamin A is found only in animals; plants contain the precursor, carotene.<br>Animals are able to store considerable vitamin A, but because of their greater requirements and less storage, young animals suffer from a deficiency much sooner than those that are mature.<br>Both carotene and vitamin A are readily destroyed by oxidation, thus resulting in considerable losses in processing and storing (as in making or storing of hay). |
| Vitamin D | Affects all farm animals, including poultry. | Aids in the assimilation and utilization of calcium and phosphorus and necessary in normal bone development of animals, including the bones of the fetus. | Rickets in young.<br>Osteomalacia in adults.<br>*Chicks:* Reduced growth, soft bones (rickets), leg deformities.<br>*Hens:* Poor eggshells and lowered hatchability. | Vitamin $D_2$ (irradiated ergosterol), the plant form.<br>Vitamin $D_3$, the animal form.<br>Sunlight.<br>Sun-cured hays.<br>Cod and certain other fish-liver oils.<br>Irradiated yeast. | Most mammals can use either $D_2$ or $D_3$, but birds require vitamin $D_3$.<br>When animals are exposed sufficiently to direct sunlight, the ultraviolet light in the sunlight penetrates the skin and produces vitamin $D_3$ from traces of 7-dehydrocholesterol in the tissues.<br>Tissue storage is very limited.<br>The vitamin D requirement is less when a proper balance of calcium and phosphorus exists. |

(*Continued*)

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Table 1-2
Animal Vitamin Chart
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| Name of Vitamin | Animals Most Affected | Functions | Some Deficiency Symptoms | Good Sources for Animals | Comments |
|---|---|---|---|---|---|
| Vitamin E | Calves, sheep, horses, poultry, rats, and perhaps certain other animals. | Antioxidant.<br>Muscle structure.<br>Reproduction. | Muscular dystrophy (stiff lamb disease and white muscle disease).<br>Reproductive failure.<br>Steatitis.<br>*Chicks:* Encephalomalacia (crazy chick disease), exudative diathesis.<br>*Hens:* Poor hatchability.<br>*Turkeys:* Myopathy of the gizzard. | Alpha-tocopherol.<br>Germ or germ oils of plants.<br>Green plants.<br>Green hays. | Vitamin E is widely distributed in all natural feeds.<br>Utilization of vitamin E is dependent on adequate selenium. |
| Vitamin K | Likely all species. | Essential for prothrombin formation and blood clotting. | Prolonged blood clotting time, generalized hemorrhages, and death in severe cases. | Menadione (vitamin $K_3$).<br>Green pastures.<br>Well-cured hays.<br>Fish meal.<br>In general, this factor is widely distributed in normal farm rations. Also, all classes of farm animals synthesize it. | Vitamin K has definite value in human therapy where clotting of the blood is impaired due to a deficiency of the vitamin.<br>Menadione is widely used commercially as a source of vitamin K.<br>Well known antagonists of vitamin K are dicoumarol and warfarin. |
| **The water-soluble vitamins:**<br>Vitamin $B_{12}$ | Swine, rats, poultry, and man.<br>Ruminants synthesize $B_{12}$ unless cobalt is deficient. | Coenzyme in several enzyme systems.<br>Closely linked with folic acid. | All animals show retarded growth.<br>Pigs show uncoordinated hind leg movements; and there's reproductive failure in sows.<br>Eggs from $B_{12}$-deficient hens fail to hatch. | Synthetic $B_{12}$.<br>Protein supplements of animal origin.<br>Fermentation products. | $B_{12}$ is apt to be lacking in swine and breeder poultry rations. |
| Biotin | Required by all species. | Component of several enzyme systems. | Pigs exhibit spasticity of the hind legs, cracks in the feet, and a dermatitis. There is also lowered efficiency of feed utilization.<br>Chicks and turkey poults show dermatitis and perosis.<br>*Hens:* Poor hatchability. | Synthetic biotin.<br>Yeast, milk, egg yolk, liver, and kidney are especially rich sources of biotin. | Ordinary farm rations probably contain ample biotin, or farm animals synthesize all they need.<br>Biotin is rendered unavailable by raw egg white. |
| Choline | Swine, rats, and poultry. Choline deficiency has not been observed in man. | Involved in nerve impulses.<br>A component of phospholipids.<br>Donor of methyl groups. | Fatty livers in most species.<br>Kidney hemorrhaging.<br>In swine, abnormal gait in growing pigs and reproductive failure in adult females.<br>In chicks, slipped tendon (perosis). | Choline chloride.<br>Choline content of normal feed is sufficient. | With a high-protein diet, enough choline is synthesized from certain precursors and amino acids. Deficiency symptoms are more readily obtained as the protein content is lowered. |
| Folic acid (folacin) | All animals and birds may be affected. | Related to $B_{12}$ metabolism.<br>Metabolic reactions involving incorporation of single carbon units into larger molecules. | Poor growth.<br>Macrocytic anemia. | Synthetic folacin.<br>Some animal proteins; well-cured, green leafy alfalfa; green pastures. | Folic acid is widely distributed in both plants and animals. It was given this name because of the abundance of the factor in plant leaves. |

(*Continued*)

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Table 1-2
Animal Vitamin Chart
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| Name of Vitamin | Animals Most Affected | Functions | Some Deficiency Symptoms | Good Sources for Animals | Comments |
|---|---|---|---|---|---|
| Inositol | Not clearly established. | Not known. | Spectacled-eye appearance in rats. | Synthetic inositol.<br>All feeds. | Widely distributed in animal feeds.<br>Synthesized in intestines. |
| Niacin (nicotinic acid) | It is a dietary essential of pigs, chickens, monkeys, and man.<br>Apparently synthesized in the digestive tract of ruminants (sheep and cattle) and the horse. | Constituent of coenzymes.<br>Hydrogen transport. | Reduced growth and appetite.<br>Swine exhibit diarrhea, vomiting, dermatitis, unthriftiness, and ulcerated intestine.<br>Chicks show poor feathering, scaly dermatitis, and sometimes, a "spectacled eye."<br>Dogs show a darkening of the tongue (blacktongue) and mouth lesions.<br>Man develops pellagra characterized by a bright red tongue, mouth lesions, anorexia, and nausea. | Synthetic niacin.<br>Animal by-products.<br>Green alfalfa is a fair source. | Niacin present in most cereal grains is not available to the pig and other simple-stomached animals.<br>Niacin can be synthesized in the body from surplus tryptophan.<br>Mature ruminants do not need dietary niacin under most conditions because of synthesis of rumen microflora. |
| Pantothenic acid | Rats, dogs, pigs, chickens, and turkeys. Synthesized in rumen of cow and sheep; perhaps the horse also synthesizes it. | Component of coenzyme A, required for energy metabolism. | All species exhibit reduced growth, loss of hair, and enteritis.<br>Mature ruminants synthesize pantothenic acid in rumen. Signs of deficiency in calves are rough coat, dermatitis, anorexia, and loss of hair around eyes.<br>Pigs develop "goose-stepping" gait.<br>Chicks show dermatitis and embryonic death.<br>Dogs vomit and show fatty infiltration of liver. | Calcium pantothenate.<br>Fish solubles. | Grain is very deficient in pantothenic acid.<br>Of all B vitamins, it is most likely to be deficient under drylot conditions. |
| Para-aminobenzoic acid | Essential growth factor for microorganisms. | Not clearly established. | Not demonstrated in animals. | Synthetic para-aminobenzoic acid.<br>Not well known. | Abundantly synthesized in intestines. |
| Pyridoxine ($B_6$) | $B_6$ is a dietary essential for the rat, pig, chick, and dog. It is synthesized in the rumen of cattle and sheep and perhaps in the cecum of the horse; thus, no deficiency symptoms in these species have been reported. | As coenzyme in protein and nitrogen metabolism.<br>Involved in red blood cell formation.<br>Important in endocrine system. | All species exhibit convulsions.<br>Pigs show anorexia and poor growth.<br>Chicks show retarded growth and abnormal feathering.<br>Hens show lowered egg laying and hatchability. | Synthetic vitamin $B_6$.<br>Cereal grains and their by-products.<br>Rice bran and polished rice.<br>Green pastures.<br>Well-cured alfalfa hay.<br>Yeast. | Normally, animal rations are not lacking in vitamin $B_6$. |
| Riboflavin ($B_2$) | Thought to be required by all animals, but deficiency symptoms not observed in ruminants, perhaps due to rumen synthesis. Deficiency symptoms noted in poultry, swine, and horses. | Promotes growth and functions in the body as a constituent of several enzyme systems and as such is important in carbohydrate and amino acid metabolism. | Retarded growth in most species, with a wide variety of other symptoms somewhat variable with the species. Periodic ophthalmia (moon blindness) in horses; reproductive failure in the sow, and slow growth, anemia, diarrhea, unthrifty appearance, eye opacities, and an abnormal gait in the young pig; and curled toe paralysis in birds. | Synthetic riboflavin.<br>Green pastures.<br>Well-cured, green, leafy hays.<br>Grass silage.<br>Milk and milk products.<br>Meat scraps and fish meal. | Grains are a poor source of riboflavin. Many common rations are borderline or deficient in riboflavin, especially swine and poultry rations. |

*(Continued)*

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Table 1-2
Animal Vitamin Chart
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| Name of Vitamin | Animals Most Affected | Functions | Some Deficiency Symptoms | Good Sources for Animals | Comments |
|---|---|---|---|---|---|
| Thiamin ($B_1$) | All animals must have a dietary source, unless there is rumen synthesis, as in cattle and sheep. | As a coenzyme in energy metabolism.<br>Promotes appetite and growth, required for normal carbohydrate metabolism, aids reproduction. | Reduction in appetite (anorexia) and loss in weight.<br>Cardiovascular disturbances.<br>Lowered body temperature.<br>Chastek paralysis in mink and foxes.<br>*Chicks:* Polyneuritis (retraction of the head).<br>*Hens:* Lowered egg production.<br>Beriberi (in man). | Thiamin hydrochloride.<br>Green pastures.<br>Well-cured, green, leafy hays.<br>Cereal grains.<br>Peas.<br>Brewers' yeast. | Seldom deficient in animals.<br>Some fish feeds possess an enzyme—thiaminase—which is antagonistic to thiamin.<br>Fats in particular have been shown to exhibit a thiamin-sparing effect. |
| Vitamin C (ascorbic acid) | Dietary need is limited to man, the guinea pig, and the monkey. Probably required by other species but synthesized in the body. | Collagen formation.<br>Formation of the intercellular substances of the teeth, bones, and soft tissues, increases resistance to infection, promotes firm gums. | Scurvy; swollen, bleeding and ulcerated gums; loosening of teeth, and weak bones. | Ascorbic acid.<br>Citrus fruits.<br>Green pastures.<br>Well-cured hays. | Ordinary farm rations and body synthesis provide adequate vitamin C. |

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# INTRODUCTION TO FEEDS

Nutrition and feeds are the critical cornerstones of livestock development for all farmers around the world. The first step in moving from a survival, free range environment to a higher level of production is to improve the nutrition of the animal through the appropriate use of different types of feedstuffs. Given that livestock production, even in small third world villages, is a complex operation, one must be able to tailor make recommendations for small farmers. This includes consideration of all available feedstuffs and their costs, availability, the breed of his other animals, marketing of the animals, storage of feeds, and other. Since volunteers may be working with farmers who have very limited resources and who traditionally are more concerned with the survival of their animals than improved production, they must consider several points. The first year of volunteer service should be used in part to conduct an exhaustive search of all available feeds for animals in the local area. The questions contained in the village livestock survey can be used as a guide in obtaining needed information. With this information, the volunteer can then balance a variety of feed rations, determine their costs and potential profit, and decide if a change in the level of production is possible. The acid test a volunteer should use in recommending a feeding practice to a farmer is quite simple: Will it increase the profit of the farmer's operation? If the answer is yes, then the volunteer must still consider other social and agricultural concerns before recommending the practice. However, if the answer is no, or if the risk of potential loss outweighs potential profit, then the feeding practice should not be recommended.

Finally, it is the opinion of the author that the solution to world hunger is not necessarily found in increased livestock production. In villages where there is a chronic shortage of cereal grains, such as corn and millet, they should not be fed to animals (even when it is profitable). Under such circumstances, work with chickens and swine (monogastrics) is out of the question. However, there may still be possibilities of increasing production levels of goats (ruminants) and rabbits (nonruminant herbivores).

In order to discuss the use of different feedstuffs and feeds in a balanced ration it is important that we clearly define the terms we will be using. Therefore, we offer the following definitions:

**FEEDS:** Feeds are naturally occuring ingredients or materials fed to animals for the purpose of sustaining them.

**FEEDSTUFFS:** A feedstuff is any product, of natural or artificial origin, that has nutritional value in the diet when properly prepared.

In general, feedstuffs may be classified into one of the following categories:

**FORAGES:** Forage is defined as vegetable material in a fresh, dried, or ensiled state (pasture, hay, or silage) which is fed to livestock.

| | |
|---|---|
| CONCENTRATES: | Concentrates are feeds that are high in nitrogen-free extract and TDN and low in crude fiber (less than 18%). |
| SUPPLEMENTS: | Feed supplements are feedstuffs used to improve the value of the basal feeds. |
| ADDITIVES: | Additives are ingredients or substances added to a basic feed mix, usually in small quantities, for the basic purpose of fortifying it with certain nutrients, stimulants, and/or medicine. |

Regardless of the criteria used to classify them, there are always some feedstuffs that do not fit into any one category or which fit the criteria of more than one class. However, the volunteer need not be concerned relative to the precise classification of each feedstuff. Rather, he or she should familiarize himself with the characteristics, along with the conditions, that affect the nutritive value of each available feed as it pertains to the species of animal he or she is feeding and his or her particular project.

Following are 8 different catagories of feedstuffs with information about each which includes a definition, general characteristics, tropical examples of each, limitations in their use, as well as the animal(s) that more commonly use that particular feedstuff.

## 1. Dry Roughages and Forages

Dried vegetable matter of material averaging more than 18% fiber that is fed to animals. Examples of this would include tropical grasses such as elephant grass & bermuda grass, legumes such as alfalfa, clover, leucaena, and stylo. These forages can be cut into hay and stored for use during the dry season when fresh forage is unavailable. They are used primarily as feed for goats, cattle, and rabbits. Forage's general characteristics include: Low digestibility (due to high lignin content), low in energy, bulky, high in fiber (greater than 18%), high in calcium and phosphorus, a good source of fat soluble vitamins, high in the B complex vitamins, and variable in protein content. For example, the legumes may have 20% protein, good quality grass hay has 8% protein, and wheat straw has only 3 to 4% protein. Other sources of dry roughage include straw, fodder, stover, hulls, and shells. Hay has an advantage in that it is an excellent way to store forage over extended periods of time yet it requires considerable labor or expensive equipment to harvest it, can create considerable loss of vegetative matter through shattering of the plant, and the curing process is subject to weather conditions than can cause significant losses in dry matter content and vitamin A.

## 2. Pasture Range Plants & Green Forages

Pasture range plants are classified as one of the following:

Grass: In grassland agriculture, grass refers to the forage species of the Gramineae (i.e. grass) family grown alone or with a legume. Legume: Plants, such as alfalfa or clover, that obtain nitrogen through rhizobia bacteria that live in their fine root hairs. Browse: The edible parts of woody vegetation such as leaves, stems, and twigs from bushes. Forbs: Any non-grasslike range herb which animals eat (commonly known as weeds).

Pastures vary greatly in quality depending upon rainfall, stage of maturity, soil fertility, level of grazing, and the types of grasses or legumes grown in the pasture. Tame pastures are those that are irrigated or receive at least 20 inches of rainfall annually. These pastures generally contain improved grass varieties. Native pastures receive less than 20 inches of annual rainfall and contain local grass varieties. Just like the dried roughages and forages these are normally fed to goats, cattle, and rabbits, however, brood sows can be maintained on pasture land as well. Their general characteristics are similar to dry forages, the only difference being that the green forages and pastures contain up to 85% moisture content. The farmer must limit the use of these plants to avoid overgrazing, bloat, depletion of the soil through erosion, and decreasing the nutrient value of the plant. Ideally, grasses should be grazed at 10 to 20 centimeters of height to gain the full nutritive value of the plant. Listed below are some advantages and disadvantages of pastures and green forages.

> Advantages: 1. Lowered feed costs; 2. Reduced chance of nutritional deficiencies; 3. Reduced threat of communicable disease; 4. Lowered capital investment costs, i.e. buildings; 5. Reduced management time and skills; 6. Good soil conservation; 7. Reduced incidence of parasites.
>
> Disadvantages: 1. Land used for pasture may produce a greater return for other crops; 2. It is difficult to observe the animals; 3. Soil of poor nutritive value produces forages of poor nutritive value; 4. Parasite problems may occur if pastures are not rotated.

### 3. Silages

These are fermented forages stored under anaerobic conditions in a silo. These forages must be cut in a green (moist) condition and placed in an airtight silo to yield the following results. 1. pH of 3.8 to 5.0 (acidic); 2. Anaerobic (no oxygen present); 3. Feed is 8 to 12% lactic acid.

These are fed to cattle and sometimes goats in commercial (high tech) operations. Corn and sorghum are commonly used for silage with their moisture contents at 60 to 70%. In this

In this process the micro-organisms ferment the soluble carbohydrates of feeds to produce lactic acid and volatile fatty acids. This type of storage requires a large investment of capital, equipment, and/or labor.

4. Energy Feeds

These are feeds used for their energy content. They normally contain less than 20% protein and 18% crude fiber. Examples would include:

a. Grains from cereal plants, i.e., corn, milo, and sorghum. These are low in calcium and high in organic phosphorus. Stored grains contain about 13 to 14% moisture.

b. Milling by-products such as corn gluten, corn bran, and rice hulls.

c. Roots, nuts, and fruits such as cassava, taro, peanuts, and rice bull.

d. Fats and oils. These contain 2.25 times the energy of carbohydrates and should be limited in feed rations to 5% for monogastrics. These feeds are given primarily to monogastrics such as swine and chickens rather than ruminants or nonruminant herbivores. For limitations on their usage, check the preparation guidelines for each individual feed-stuff in this category because their limitations vary greatly. Their use in the Third world is often restricted due to unavailability, prohibitive cost, competition for demand with humans, and difficulties with storage.

5. Protein Supplements

Protein supplements are feedstuffs containing more than 20% protein. Protein levels in livestock rations are extremely important for young animals and animals in high production. Muscle growth, egg production, wool and hair growth, lactation, and gestation all require considerable quantities of protein because the products of these types of production are largely protein in composition. Protein supplements can be from vegetable sources such as soybeans, cottonseed, safflower, sunflower, and peanuts. These are of moderate protein quality since they have limiting amino acids. Protein supplements from animal protein are of higher quality since they do not have the limiting amino acids. These are commonly made from tankage, blood, fish, and other inedible animal tissues. Protein supplements are fed to monogastrics rather than ruminants who can synthesize their own protein when supplied with nitrogen. Limitations in the usage of these supplements are of 2 types: one is nutritional (which can be checked by feedstuff in the feed preparation chart) and the other is due to availability, cost, and marketing practices in different countries.

6. Mineral Supplements

These are minerals added to a ration to maintain nutritional balance. They are limited to 1 to 2% of a balanced ration or may be self fed. The macro-minerals are salt, calcium, phosphorus, manganese, and sulfur. The micro- minerals are copper, iron, iodine, zinc, and cobalt. These minerals are needed by both monogastrics and ruminants. In many developing countries where premixed minerals for animals are scarce or expensive, oyster shell, ash from wood fires, and calcium sources are used instead.

7. Vitamin Supplements

These are generally not available in the rural areas of developing countries. They tend to be expensive when available and often of questionable quality since they may be sent overseas by a Western corporation after they have passed the expiration date on the label or have been produced in the Third world where quality control can be a problem. When used, they generally occupy no more than 1% of the ration. Listed below are the vitamins most often deficient in the rations for each animal:

Adult ruminants - Vitamins A, D, & E.
Poultry - Vitamins A, B, D, E, and K.
Swine - A, D, E, Riboflavin, Niacin, Pantothenic acid, B 12, & Choline.

These are the vitamins that you should supplement for if possible and appropriate.

8. Additives

These are normally used to 1) Improve rate and/or efficiency of weight gain, 2) prevent certain diseases, and 3) preserve feeds. Antibiotics such as Tylosin, oxytetracycaline, and penicillin are additives to feed because there is evidence that they 1) reduce the incidence of subclinical infections in the digestive and respiratory tract, 2) they stimulate appetite and have a nutrient sparing effect, and 3) they stimulate certain enzyme systems. Furthermore, hormones such as stilbestrol are sometimes used in high management situations with cattle and poultry because they increase feed consumption and weight gain. The use of stilbestrol has been banned in the U.S. by the Food and Drug Administration. In the third world it will be found not at the village or survival level of livestock production but in the high technical operations.

## Table 1-3
## Feed Efficiency

### FEED TO FOOD EFFICIENCY RATING BY SPECIES OF ANIMALS, RANKED BY PROTEIN CONVERSION EFFICIENCY

(Based on Energy as TDN or DE and Crude Protein in Feed Eaten by Various Kinds of Animals Converted into Calories and Protein Content of Ready-to-Eat Human Food)

| Species | Unit of Production (on foot) | Feed Required to Produce One Production Unit | | | | Dressing Yield | | Ready-to-Eat; Yield of Edible Product (meat and fish deboned and after cooking) | | | | Feed Efficiency[4] (lb feed to produce one lb product) | | Efficiency Rating | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Pounds | TDN[1] | DE[2] | Protein | Percent | Net Left | As % of Raw Product (carcass) | Amount Remaining from One Unit of Production | Calorie[3] | Protein[3] | | | Calorie Efficiency[5] | | Protein Efficiency[6] | |
| | | (lb) | (lb) | (kcal) | (lb) | (%) | (lb) | (%) | (lb) | (kcal) | (lb) | (%) | (ratio) | (%) | (ratio) | (%) | (ratio) |
| Broiler | 1 lb chicken | 2.4[7] | 1.94[8] | 3,880 | 0.21[8] | 72[13] | 0.72 | 54[14] | 0.39 | 274 | 0.11 | 41.7 | 2.4:1 | 7.1 | 14.2:1 | 52.4 | 1.9:1 |
| Dairy cow | 1 lb milk | 1.11[7] | 0.9[8] | 1,800 | 0.1[8] | 100 | 1.0 | 100 | 1.0 | 309 | 0.037 | 90.0 | 1.11:1 | 17.2 | 5.8:1 | 37.0 | 2.7:1 |
| Turkey | 1 lb turkey | 5.2[7] | 4.21[8] | 8,420 | 0.46[8] | 79.7[13] | 0.797 | 57[15] | 0.45 | 446 | 0.146 | 19.2 | 5.2:1 | 5.3 | 18.9:1 | 31.7 | 3.2:1 |
| Layer | 1 lb eggs (8 eggs) | 4.6[7] | 3.73[8] | 7,460 | 0.41[8] | 100 | 1.0 | 100[12] | 1.0[12] | 616 | 0.106 | 21.8 | 4.6:1 | 8.3 | 12.1:1 | 25.9 | 3.9:1 |
| Rabbit | 1 lb fryer | 3.0[19] | 2.20 | 4,400 | 0.48 | 55[19] | 0.55 | 79[19] | 0.43 | 301 | 0.08 | 35.7 | 2.8:1 | 6.8 | 14.6:1 | 16.7 | 6.0:1 |
| Fish | 1 lb fish | 1.6[9] | 0.98 | 1,960 | 0.57 | 65[10] | 0.65 | 57[11] | 0.37 | 285 | 0.093 | 62.5 | 1.6:1 | 14.5 | 6.9:1 | 16.3 | 6.1:1 |
| Hog (birth to 200 lb) | 1 lb pork | 4.9[18] | 3.67 | 7,340 | 0.69 | 70[16] | 0.70 | 44[17] | 0.31 | 341 | 0.088 | 20.4 | 4.9:1 | 4.6 | 21.5:1 | 12.7 | 7.8:1 |
| Beef steer (yearling finishing period in feedlot) | 1 lb beef | 9.0[18] | 5.85 | 11,700 | 0.90 | 58[16] | 0.58 | 49[17] | 0.28 | 342 | 0.085 | 11.1 | 9.0:1 | 2.9 | 34.2:1 | 9.4 | 10.6:1 |
| Lamb (finishing period in feedlot) | 1 lb lamb | 8.0[18] | 4.96 | 9,920 | 0.86 | 47[16] | 0.47 | 40[17] | 0.19 | 225 | 0.052 | 12.5 | 8.0:1 | 2.3 | 44.1:1 | 6.0 | 16.5:1 |

[1] TDN pounds computed by multiplying pounds feed (column to left) times percent TDN in normal rations. Normal ration percent TDN taken from M.E. Ensminger's books and rations, except for following: dairy cow, layer, broiler, and turkey from *Agricultural Statistics 1974*, p. 358, Table 518. Fish based on averages recommended by Michigan and Minnesota Stations and U.S. Fish and Wildlife.

[2] Digestible Energy (DE) in this column given in kcal, which is 1 Calorie (written with a capital C), or 1,000 calories (written with a small c). Kilocalories computed from TDN values in column to immediate left as follows: 1 lb TDN = 2,000 kcal.

[3] From *Lessons on Meat*, National Live Stock and Meat Board, 1965.

[4] Feed efficiency as used herein is based on pounds of feed required to produce 1 lb of product. Given in both percent and ratio.

[5] Kilocalories in ready-to-eat food ÷ kilocalories in feed consumed, converted to percentage. Loss = kcal in feed ÷ kcal in product.

[6] Protein in ready-to-eat food ÷ protein in feed consumed, converted to percentage. Loss = pounds protein in feed ÷ pounds protein in product.

[7] *Agricultural Statistics 1974*, p. 358, Table 518. Pounds feed per unit of production is expressed in equivalent feeding value of corn.

[8] Since pounds feed (column No. 2) per unit of production (column No. 1) is expressed in equivalent feeding value of corn, the values for corn were used in arriving at these computations. No. 2 corn values are TDN, 81%; protein, 8.9%. Hence, for the dairy cow 81% × 1.11 = 0.9 lb TDN; and 8.9% × 1.11 = 0.1 lb protein.

[9] Data from report by Dr. Phillip J. Schaible, Michigan State University, *Feedstuffs*, April 15, 1967.

[10] *Industrial Fishery Technology*, ed. by Maurice E. Stansby, Reinhold Pub. Corp., 1963, Ch. 26, Table 26-1.

[11] Ibid. Reports that, "Dressed fish averages about 73% flesh, 21% bone, and 6% skin." In limited experiments conducted by A. Ensminger, it was found that there was a 22% cooking loss on filet of sole. Hence, these values - 73% flesh from dressed fish, minus 22% cooking losses - give 57% yield of edible fish after cooking, as a percent of the raw dressed product.

[12] Calories and protein computed basis per egg; hence, the values herein are 100% and 1.0 lb, respectively.

[13] *Marketing Poultry Products*, 5th Ed., by E. W. Benjamin et al., John Wiley & Sons, 1960, p. 147.

[14] *Factors Affecting Poultry Meat Yields*, University of Minnesota Sta. Bull. 476, 1964, p. 29, Table 11 (fricassee).

[15] Ibid. Page 28, Table 10.

[16] Ensminger, M. E., *The Stockman's Handbook*, 4th Ed., Sec. XII.

[17] Allowance made for both cutting and cooking losses following dressing. Thus, values are on a cooked, ready-to-eat basis of lean and marbled meat, exclusive of bone, gristle, and fat. Values provided by National Live Stock and Meat Board (personal communication of June 5, 1967, from Dr. Wm. C. Sherman, Director, Nutrition Research, to the senior author), and based on data from *The Nutritive Value of Cooked Meat*, by Ruth M. Leverton and George V. Odell, Misc. Pub. MP-49, Appendix C, March 1958).

[18] Estimates by the authors.

[19] Based on information in *Commercial Rabbit Raising*, Ag. Hdbk. No. 309, USDA, 1966, and *A Handbook on Rabbit Raising*, by H. M. Butterfield, Washington State College Ext. Bull. No. 411, 1950.

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## LIVESTOCK FEED RATIONS

In preparing feed rations, a volunteer should consider: the nutrient requirements of the species, the breed of the animal, the feeding and management practices of the farmer, the cost of available feeds, the nutrient values of all available feeds, and the probable feed to gain ratio for the animal with the ration. These considerations are important because of their effect on the farmer's profit and the health of the animal. The mathematical process of balancing a feed ration and the actual hand mixing of a feed ration will be covered in class. The quality of the feed ration should always match the level of production for each farmer.

In balancing feed rations we will use either Metabolizable Energy, Total Digestive Nutrients, or Digestable Energy as the measure of the energy value of the feed. Crude Protein or Digestable Protein will be used to measure protein percentages. Lysine will be the only amino acid that we balance for because it is the most limiting of the amino acids in its effects on growth. Calcium and phosphorus levels are critical in the rations of animals in production--growth, egg production, and lactation. Calcium and phosphorus share a close relationship in bone formation and metabolism. Therefore we will balance the levels of these 2 major minerals in our feed rations.

It should be noted that all feed ingredients fall into 1 of the following categories:

1. Dry forages and roughages
2. Pasture, range plants, and forages fed green
3. Silages
4. Energy feeds
5. Protein supplements
6. Minerals
7. Vitamins
8. Additives

Furthermore, generally, monogastrics need higher quality protein than ruminants which can consume more bulk and high fiber. Protein quality varies from high to low in different feeds such as fish meal to corn. Grains contain little Calcium. For monogastrics, high level production feeds always contain a source of animal protein in order to provide complete amino acid balance. Ruminants, unlike mongastrics, can synthesize protein from simple nitrogen compounds. Carbohydrates, lipids (fats & oils), protein, minerals, vitamins, and water are the 6 classes of nutrients required for maintenance, growth, and reproduction.

Listed below are many different feed ingredients and information on their use in feed rations, preparation, and limitations.

1. Alfalfa
   Perennial, leguminous forage plant. Can be fed green to rabbits or cut, sun dried, and stored for hay to be fed to ruminants. Can be ground into a meal for use in rations for monogastrics. Limit of 20% in swine and chicken rations. Limit of 22% moisture content during storage.

2. Bananas
Fill problem. Can be unpalatable and toxic if green. Meets 50 to 75% of energy requirements in all animals.

3. Barley
Poor protein quality. Barley should be ground or crushed except for sheep or when fed with other whole grains to poultry. Can cause bloat in cattle. Can replace corn for swine and chickens with a slight drop (10 to 30%) in weight gain. Produces eggs with a very light colored yolk.

4. Beans, field
Poor protein quality, low in amino acids. Feed beans only to pigs and chickens, entire pod to goats and rabbits. Sun dry, limit to 40% of protein requirement.

5. Beet pulp
Rich in carbohydrates, low in protein, poor in fat, and high in fiber. Palatable to cattle, goats, and sheep. Not a feed for monogastrics.

6. Bermunda Grass
Important pasture grass for cattle, sheep, and goats. Common in tropical areas, can be used for hay.

7. Blood meal
Boil for 30 minutes or until it coagulates--then sun dry for 2 to 3 days. High in excellent quality protein. Unpalatable to poultry. Limit to 5% of ration.

8. Bone meal
Phosphorus supplement. Difficult to prepare--must be cooked under steam pressure or for longer periods in open kettles and then sun dried. Use only 1 or 2% in rations.

9. Brewers Dried Grain
Sun dry 2 to 3 days. Use for swine and poultry. Fill problems. If of good quality can be used for chicks and pigs as exclusive protein source.

10. Buckwheat
Problems with palatability. Should form only one third of the grains in the ration. Ground for all livestock except poultry. Produces soft pork meat.

11. Casein
Solid residue remains after the acid or rennet coagulation of defatted milk. Excellent protein quality. Generally too expensive to use as livestock feed.

12. Cassava meal (manioc, yuca, & tapioca)
Extremely deficient in methionine. Can be fed (cooked or raw) to pigs, cattle, sheep, and goats. Must be mixed with water

or molasses for poultry. Leaves are richer in protein and minerals than root. Boil roots for 30 minutes and sun dry for 2 to 3 days. Storage is difficult.

13. Chick peas
Pulse seed common to subtropics. Can be fed raw to swine--for chickens boil 30 minutes and then sun dry. Good source of lysine but low in methionine and cystine. Use up to 50% as protein source. Harvesting and supply problems.

14. Clover hay
Good for cattle, sheep, goats, and rabbits. Can be fed green --watch for bloat.

15. Copra Meal
For chickens and pigs. Boil for 30 minutes. Use only 20% in ration. Low in lysine and methionine.

16. Corn, yellow dent
Excellent energy source for all animals. Should be shelled and cracked before being fed. Poor protein quality. Should be ground for chicken.

17. Corn and cob meal
Used for cattle, less common for goats & sheep. Not preferred for swine, rabbits, or poultry. Cob usually forms 20% of the meal.

18. Corn gluten feed & meal
High in fiber and best for cattle. Very limited for chickens and pigs.

19. Cottonseed meal
Low in lysine, excellent protein sources for ruminants. Limit it to 50% of protein source for pigs. Must be industrially processed. Contains gossypol which limits its use for pigs and chickens. Limit to 10% of ration for swine and 5% for chickens.

20. Crab
1.6 pounds of crab meal can replace 1 pound of fish meal. Must remove salt and sun dry. Can be sole protein source.

21. Distillers grain
Bulky, fill problem. Limit to 10% of ration for poultry. Sun dry 2 to 3 days. Limit to 50% of protein requirement for all animals. Poor quality protein due to amino acid imbalance.

22. Feather meal
Must be industrially processed. Can be used as sole protein source. Limit to 5% of ration for poultry.

23. Field peas
Palatable for all livestock. Feed to swine and rabbits raw. For chickens boil 30 minutes and sun dry for 2 to 3 days. Can be used as sole protein source. Do not feed pods to pigs and chickens. Harvest and supply problems.

24. Fish meal solubles
Sole mineral source and major protein source for all animals. Boil 30 minutes and sun dry for 2 to 3 days for pigs and poultry. Limit to 10% of ration for pigs, rabbits, and chickens. Can flavor meat.

25. Flax
Used to make linseed oil. Produces soft pork meat and can have a laxative effect. Used mainly for cattle and never for chickens.

26. Hominy
A milling by-product of corn. Fed to all livestock.

27. Kudzu
The curse of Georgia. Equal to alfalfa in nutritive value and palatibility for ruminants. Storage and collection is difficult.

28. Leucaena (Ipil-Ipil)
5% limit in ration for chickens and pigs due to toxicity. 30% for cattle and 20% for goats. Possible harvest and supply problems.

29. Meat and bone meal
Excellent amino acid balance, used as protein supplements for swine and poultry. Boil for 30 minutes and sun dry.

30. Milk, dehydrated
Generally too expensive to feed livestock.

31. Millet
Should always be ground or rolled except for poultry. Not equal to corn for ME.

32. Molasses, beet and cane
Limit to 10% in growing chickens and pigs, 20% to adult chickens & pigs. Fill problem little usage. Used commonly for cattle, can cause scours in pigs.

33. Oats
Palatable to all livestock. Bulky, can reduce cannibalism in poultry. Popular dairy feed. Fill problem with swine due to bulk and fiber content. For swine it equals 80% of the value of corn pound for pound. Limit to 10 to 15% of poultry ration. Palatable to rabbits.

34. **Peanuts**
Can feed entire plant during early bloom to rabbits--good for forage. Use only the nut for pigs and chickens. Must be dry --humidity forms toxic molds. Medium quality protein. Use for up to 50% of protein requirements.

35. **Peanut meal**
Becomes rancid quickly in warm, humid climates. Excellent protein supplement for all animals - highly palatable to swine.

36. **Peas**
Highly palatable to all livestock. Can be substituted for grains. Can be fed raw to swine, cattle, and rabbits. For chickens boil 30 minutes and sun dry for 48 hours. Can be used as a sole protein source. Do not feed pod to chickens and pigs. Harvest and storage problems.

37. **Pineapple bran**
Feed only to cattle.

38. **Plantains**
See bananas.

39. **Potatoes**
Boil 30 minutes and sun dry for 2 days for swine and poultry. Good energy source. Chicks and piglets must have them peeled. Fill problem. Basis for survival diets. 4 to 1 ratio in energy values with grains. Feed raw to cattle.

40. **Rapeseed meal**
Must be industrially processed for pigs and chickens. May cause abortions in breeding sows. High quality plant protein --use for only 25% of protein requirements for pigs and chickens. Rather unpalatable. Toxic if not processed correctly. Avoid for poultry starter rations, limit to 10% of rations in fryers.

41. **Rice (bran, broken, & polishings)**
Bran should be hull-free. Energy basis of a survival diet, low in amino acids. Use up to 75% of ration for laying hens. Rice bran is fed mainly to ruminants. Rice polishings fed primarily to swine. Can cause serious scours in young pigs and produce soft pork meat. Should be cracked or ground before feeding.

42. **Rye grain**
Lower palatability than other grains, high in protein, liked by sheep. Should be ground for all animals except sheep. Ergot contamination can cause it to be toxic. High quantities work as a laxative. Grind for chickens and limit to 20% of the ration.

43. Safflower meal
Not very palatable--primarily for ruminants. Must be industrially processed for pigs and chickens and limited to 10% of ration due to high fiber content.

44. Sesame meal
Difficult to harvest. Soak seeds in water to remove hulls. High in CA and PH. Palatable to all livestock and stores well. Mild laxative, produces soft pork. Use only to 50% of protein requirements.

45. Shrimp
Must remove salt--sun dry. Can be used as a sole source for monogastrics.

46. Sorghum
Sun dry the fodder, excellent energy source for all animals. Limited in amino acids and palatibility may be a problem. Feed fodder only to cattle. Should be ground except for sheep. Palatable to rabbits. Feed value equal to corn. Green grain sorghum plants are poisonous due to the presence of prussic acid. Some varieties grown for silage. Dry well to eliminate prussic acid.

47. Soybeans and soybean meal
Boil for 30 minutes and sun dry for 2 to 3 days for chickens and pigs. Can be fed raw to ruminants. Should be ground before feeding. SBM is a better feeedstuff than whole soybeans for monogastrics. Excellent protein supplement for all animals. High in lysine and can produce soft pork.

48. Sugar
Excellent energy source for all animals except piglets and chicks. Not normally an animal feed due to expense.

49. Sunflower seeds
Require industrial processing for pigs and chickens and should be limited to 25% of protein requirement for monogastrics. High in fiber and low in amino acids. Remove hull by soaking. Can be used for silage in cool climates. Hulls are used in ruminant feeds and the meal in nonruminant feeds. Good to combine with a high lysine supplement like fish meal.

50. Taro
Boil 30 minutes and sun dry. Unknown inhibitors for chickens and pigs. Cooked tubers good for all livestock. Leaves are relished by cattle and sheep.

51. Wheat bran
Formed by the coarse outer coatings of the wheat kernel. Very bulky. A popular stock feed in the U.S. Can work as a laxative. Palatable to all livestock.

52. **Wheat grain**
Important grain crop. Should be cracked and coarsely ground for all animals. Wheat powder is not very palatable. Limit to 50% of concentrate mix. Expense limits its use as an animal feed. Poor protein quality and low in calcium. Can be used as "finisher" for cattle and sheep. Preferred by poultry to all other grains.

53. **Whey**
A by-product of the making of cheese. Very low in protein. Fed primarily to swine. One pound of whey (dried) is equal to 13 to 14 pounds of liquid whey in nutrients. High in riboflavin.

54. **Wingbeans**
The root tuber is high in energy. Boil 30 minutes and sun dry for 2 to 3 days. The pod with seeds may be fed whole to pigs, chickens, goats, rabbits, and cattle. Can be used for at least 50% of protein requirements in all animals.

55. **Yeast, brewers**
Excellent source of highly digestable good quality protein. It can replace up to 80% of the animal protein portion of swine and poultry rations when supplemented with calcium. Contains B vitamins and unidentified growth factors.

**Conversion Factors:**

DE to ME: (for swine) DE x .96 = ME — DE - Digestable Energy

TDN to ME: 45% TDN x 36 = 1,620 ME — ME - Metabolizable Energy

TDN to DE: $45\%\ \text{TDN} \times \frac{4400}{100} = 2000\ \text{DE}$ — TDN - Total Digestive Nutrients

ME to TDN: 3,000 ME ÷ 36 = 83.3 TDN

| Calcium | % of Calcium | % of Phosphorus | Ratio |
|---|---|---|---|
| Bone charcoal | 27 | 14 | Good |
| Bone meal | 24 | 12 | Good |
| Calcite, high grade | 34 | — | — |
| Calcium carbonate | 40 | — | — |
| Dicalcium phosphate | 23 | 18 | Good |
| Dolomite Limestone | 22 | — | — |
| Gypsum | 22 | — | — |
| Limestone | 35 | — | — |
| Monocalcium Phosphate | 17 | 25 | Poor |
| Oyster Shell | 38 | — | — |
| Tricalcium Phosphate | 40 | 20 | Good |
| Wood Ash | 21 | — | — |

A good calcium, phosphorus ratio is at least 1.5 parts calcium to 1.0 parts phosphorus. The ratio can be as high as 3:1 or 4:1.
RNB 1982

# INTRODUCTION TO DISEASE

The purpose of this unit is: (1) to give trainees a better understanding of the causes, transmission, prevention, and treatment of animal diseases, (2) to allow them a clearer understanding of their own health, and how to maintain it, and (3) to become sensitive to health needs when they enter their community overseas.

By the intergration of the two components, livestock and core, on this topic, it is felt that trainees will be able to reinforce their learning in a positive way.

## Disease: A definition

Disease is a departure from a state of good health by an alteration of the internal organs or external conditions of the body. It is a disruption of the normal functioning and performance. Causes of diseases:

1. Infectious agents, or pathogens such as bacteria and virus
2. Parasites, external (e.g., ticks) or internal (worms)
3. Heredity, caused by defective genes, e.g., in humans, sickle-cell anemia, swine melanoma
4. Congenital defects caused by developmental accident during the embryonic stage or from toxic or infectious agent during pre-natal development. e.g., pullorum disease in chickens; brucellosis in pigs, goats
5. Nutritional deficencies, e.g., Kwashiorkor (protein deficiency in children), poly neuritis (vitamin B deficiency in chicks)
6. Traumatism, e.g., wounds, burns
7. Environmental stress, thermal stress heat stroke, frost bite.
8. Man, animals and man overcrowding, poor housing and sanitation facilities.

## Transmission and Spread

Two methods of transmission are horizontal and vertical.

### Horizontal

1. Direct or immediate contact with a diseased animal
   a. sexual (brucellosis)
   b. bodily contact (ring worm)
2. Contact with non-living objects, infected pens, litter, feeders, waterers.

3. Contact with disease carriers (animals infected but do not have or exhibit disease).

4. Infection in the soil, food, and/or water.

5. Air borne infections, transmitted in the air by inhalation of disease agent.

   a. Intensive transmission which has a spread of 1 km, expelled by coughing and breathing in by others.

   b. Moderated transmission which has a maximum spread of 15 meters, chronic respiratory problems can be transmitted this way.

   c. Low transmission in the air--needs tight contact (crowding) between animals to transmit pathogenic agents.

6. Infections from blood sucking arthropods such as flies, fleas, mosquitoes, lice, or ticks. Malaria (man) and anthrax (cattle) are diseases transmitted in this way.

7. Infections from organisms normally found on or in the animal's body. Streptococci are found in healthy animals but become dangerous if the animal is stressed and its defenses weakened.

8. Spoiled feed, molds, and fungi in the feed which produce toxins (mycotoxicosis and aspergelosis).

9. Fecal contamination, coccidiosis in chickens and hepatitis and cholera in both chickens and man.

   A term usually used to explain the method of transmission of a disease is vectors. These can be either mechanical such as contaminated clothes, wild birds, insects; or included in the life cycle of a parasite, that is a biological vector, where a parasite has the pathogen within its system, rather than carrying it on its legs, wings, etc. and transmits the disease by biting the animal.

Vertical

1. Embryonic: The disease is spread congenitally, that is, the ovary or uterus which is infected transmits disease to the egg or fetus.

2. Artificial insemination: Offspring infected by infectious sperm.

3. In the case of chickens, eggs can be infected by fecal contamination from a disease in the intestinal tract.

4. Hereditary: Caused by defective genes.

Disease Resistance. The animal's defense against disease carrying organisms.

1. Skin and mucous membranes: Tissue acts like a mechanical barrier to bacteria, yeast, and molds.

2. Mucous membranes produce fluid which washes away the pathogens. This primary defense is more effective against larger pathogens than viruses. If the skin is damaged by cuts, abrasions, or burns, infections may result. This means that the organism is in the body but it does not necessarily mean that the disease is present.

   Whether a disease will occur depends on the secondary defenses of the body.

Secondary defenses (ex. a cut in the skin)

1. Bleeding washes the wound and removes bacteria.

2. Phagocytes are specialized white blood cells that eat and destroy bacteria.

3. If the number of bacteria is small then healing occurs. If not, then inflammation, heat, swelling, and pus occur.

4. Pus (An accumulation of dead bacteria and tissue cells). This accumulates in a closed wound and forms an abscess.

5. Abscesses become walled off with connective tissue to prevent extension of the infection.

6. Leucocytes (white blood cells) go to the wound site to prevent infection from spreading beyond the point of introduction. With any active bacterial infection there is almost always an increase of white blood cell count. The opposite is commonly seen with viral diseases.

In normal circumstances, most infections are stopped and disease is prevented but if the body cannot produce leucocytes because of malnutrition, a long term disease, or stress, then a condition called bacteremia or septicemia develops, in which case an antibiotic would be necessary.

Besides pus, eye secretion, droplets of moisture from respiratory infections, feces and urine can move the pathogens from the site of the infection. If the infection persists and gradually wears down the animal's resistance, the infection is termed chronic. If the animal's resistance is quickly lowered leading to the rapid growth of infectious organisms, it is called acute. In the case of acute infection death usually occurs. Proper disposal of the carcass by incineration or deep burial, and decontamination of the host quarter will destroy the majority of the pathogens. If this is not done properly, disease can be spread to healthy animals.

It is possible for an animal to live with the pathogen because either the animal cannot eliminate the pathogen or the pathogen cannot lower the resistance of the animal. With humans this is how people can live a long time with parasites and other types of infectious agents. If one or the other loses the upper hand the disease will spread or the animal will be cured.

Sometimes a disease is said to be arrested. This does not mean the animal is cured because it can be subjected to periodic flare-ups of the disease. In both man and animal some deadly organisms continue to live in the excretory organs after the disease has run its course. These infectious organisms are eliminated by what is called a carrier.

Convalescent Carrier: An animal after surviving a disease is unable to rid its body of the organisms.

Immune Carrier: An animal that is immune to a disease but possesses and eliminates the disease carrying organisms from its body.

Contact Carrier: These are animals that are host to and eliminate highly deadly organisms which they have picked up from contact with another animal. The carrier is one of the great problems affecting the control of infectious diseases.

It may be easier to recognize and possibly treat a diseased animal but virtually impossible to detect a carrier.

Microorganisms which do not cause disease (Saprophytes)

1. Microorganisms in the rumen of ruminants help to break down cellulose to usable energy.
2. Utilization by ruminants of non-protein nitrogen, facilitated by microorganisms in the rumen.
3. Microorganisms useful in making cheese, yogurt, beer, wine, silage, and compost.
4. Microorganisms that are helpful in maintaining fertility of the soil.
5. Microbes that remove biodegradable waste.

Microorganisms which can cause disease (Pathogens)

1. Parasitic: they survive at the expense of the host.
2. Affinity for certain tissues (i.e., rabies attack the nervous system)
3. Differ in mode of action
    a. Some invade and destroy body cells.
    b. Some produce toxins which are poisonous.
    c. Mycotoxins form molds in feed.

4. Some have affinity for some animal species but host specificity is not absolute. Certain diseases can be between different species of animals.

## Specific

1. Bacteria

   a. One cell organisms which are members of the plant family.

   b. Some are harmless unless they show up where they do not belong (i.e., E. coli from the gut, if transferred to the urinary tract and bladder, can cause an inflammation of the bladder.

   c. Classified according to shape and arrangement of cells.

   d. Classified by staining. Gram positive, or gram negative which indicates their susceptibility to drugs or antibiotics. (i.e., Penicillin is effective only against gram +, or broad spectrum which is effective against both, usually, such as combiotic: a mixture of penicillin and streptomycin.)

## Viruses

1. The smallest living organism known. Measured in millimicrons.

2. Parasitic: They must live in body cells where they grow and multiply, they contain no energy of their own.

3. They slip through tissue with little disruption and tissue reaction (unlike bacteria).

4. Pus or phagocytes are not a defense against them.

5. They usually are tissue specific. i.e., nerve cells, skin cells, etc.

6. They can make harmless bacteria the secondary invaders.

7. They can not be destroyed by antibiotics, control is difficult. Viruses can be prevented by vaccines but these are used very little because vaccines destroy body cells as well as the parasitic virus.

8. The first evidence of viral infection may be a fever which is protective because it disrupts the virus' enviroment. However, prolonged fever may have a detrimental effect such as dehydration.

## Protozoa

1. Similar to bacteria, unicellular, miscroscopic, and capable of carrying on all life processes within a cell.

2. 15,000 to 20,000 known species.

3. i.e., Malaria in humans and cocci in chickens.

## Rickettsiae

1. Smaller than bacteria but larger than viruses.
2. They can cause intracellular infection.
3. Like viruses, they can live and multiply inside the tissue cell of the host.
4. Unlike viruses, they are sensitive to antibiotics and have a carbohydrate shell.
5. i.e., Q fever and Rocky Mountain spotted fever are both caused by them (zoonoses).

## Mycoplasma

1. A virus-like organism.
2. They can be grown in a medium free of mammalian tissue cells.
3. They are sensitive to certain antibiotics.
4. i.e., CRD in chickens.

## Fungus

1. Molds (multicellular), yeast (unicellular).
2. They can invade animal tissue to produce disease and produce potent toxins.
3. They can grow outside the animal in feed, producing toxins which are harmful to animal after being consumed. i.e., mycotoxicosis and aspergilosis.

## Parasitism (General)

1. They vary from a single cell coccidia to worms and insects.
2. They can be either totally dependent on the host animal for survival or independent part of the time.
3. The relationship of many parasites is commensalistic. That is, the parasite lives off the host without really harming it, because if it did the parasite will be homeless.
4. Some immune response is developed.
5. Knowledge of the life cycle can provide the opportunity for control without depending on drugs.

6. Parasite control through medication alone is a continuing expense without any lasting benefit.

## External Parasites

1. They damage or irritate the skin by nourishing on blood, skin, hair, feathers, or other body tissues.
2. They transmit disease by carrying certain organisms in their body which they transmit to the host while feeding or sucking blood. i.e., Rocky Mountain spotted fever from ticks to humans
3. Parasites can mechanically transmit disease organisms on their feet, mouth, wings, etc.

## Types of Parasites

1. Ticks
    a. They carry the most diseases of any type of parasite and cause considerable damage to tissues around the feeding site.
    b. This area susceptible to bacterial infections, anemia, loss of weight, and even death.
    c. Life cycle: egg, larva, nymph, and adult stages.
    d. Hard Ticks (infest domestic/wild animals and humans). They require one, two, or three hosts for each stage to develop.
    e. Soft ticks infest birds, poultry, rodents, bats, some domestic animals, and man. They are multi host ticks which feed intermittently while hosts sleep and then return to crack or crevasses to lay eggs.
2. Mites
    a. They cause mange, scabies, and ear cankers.
    b. Life cycle: egg, larva, nymph, and adults (2-3 weeks).
    c. Types: Sarcoptic mange mite and Domodectic mange mite (cause hair to fall out) and ear mange (frequently found in dogs, cats, and rabbits.
3. Lice
    a. Two types: Biting (birds & mammals) and sucking (Mammals).
    b. These are capable of transmitting disease, loss of hair or feathers, blood loss, and making animal susceptible to other infections.

c. Life cycle: eggs (nits), nymph, immature louse to adult. Eggs are usually glued to the hair shafts.

## Control and treatment

Insecticides in the form of dusts, dips, or spray.

1. You should be careful in using these because they are poisonous to man, animal, and environment when improperly applied.

2. You must know which insecticide to use for which animal, the recommended dosage, and the method of application. Also be familiar with where to apply it and how to prepare it.

3. In general, treat including bedding, feeding equipment (but not the feed or water), nest, etc.

4. If insecticides are not available, a mixture of edible oil and kerosene (2 parts to 1) can treat for parasites.

## Internal Parasites

1. The degree of injury or damages depends on number, life cycle (where migration takes place in the host), and the degree of immunity developed by the host.

   a. They can cause wounds which allow bacteria to enter or cough, bronchitis (i.e., lung worms).

   b. They can prevent proper food passage (i.e., roundworms) or absorb food intended for the host (i.e., tape worms).

   c. They can cause anemia or bloodclotting (i.e. hookworms or stronglyes)

   d. They destroy tissue (i.e., bladder worms).

   e. They cause irritation and itching (i.e., pinworms).

   f. They transmit disease and secrete toxins which destroy enzymes and red blood cells.

   Resistance to parasites is dependent on an adequate diet because protein is needed for the production of antibodies and to feed the parasites while some temporary immunity is developed.

## Types of Internal Parasites

1. Direct life cycle - one definite host, i.e., roundworms where adult worm lays fertile eggs in the host.

2. Indirect life cycle - the parasite will spend intermediate life on one or more intermediate hosts, i.e., swine acquires lungworms by eating earthworms that have consumed lungworm eggs.

## Prevention

1. Break the life cycle

    a. Rotate pastures where eggs may incubate.

    b. Remove intermediate host, i.e., provide a sanitary enviroment (fly control).

    c. Use good quality feeds.

## Treatment

1. Drugs, deworming medicine which can be animal specific and parasite specific. i.e. piperazine for chickens to treat roundworm but ceca worms are treated with phenothazine.

2. Read and follow directions carefully because overdoses can be dangerous.

3. Most worm medicines are effective only against the adult stage, therefore animals should be treated a second time (2 weeks later) to remove immature larvae.

Non-living agents which cause disease

a. Nutritional deficiencies are covered to some extent in the Introduction to Nutrition, especially the vitamin and mineral charts. For protein and energy deficiencies refer to pages 107-130 in *Where There Is No Doctor*, by David Werner.

b. Toxins: posisonous substances. Upon entering the body they destroy tissues.

Types of toxins according to their sources

a. Bacterial toxins; these cause diphtheria, tetanus, and botulism.

b. Zootoxina; these are produced by certain snakes, bees, and spiders.

c. Phytoxina; such as those produced by the castol bean plant, poisonous fungi of certain toad stools, and braken fern.

d. Poisons in metallic substances such as lead and arsenic.

## Immunity

1. It is the degree of resistance to any specific organism and it can be complete or partial.

2. Defense against viral infections relies heavily on immunity. Immunity is also involved in fighting larger pathogens such as bacteria but to a lesser degree.

3. Immunity is highly selective. That is, protection against one organism does not protect against another with very few exceptions.

Immunity system - How it happens

The body produces a protein called antibody which is modified and found in the globulin fraction of the blood (humoral antibody). This antibody is formed in response to stimulation by a foreign protein (antigen). The antigen - antibody reaction is the fundamental way in which pathogenic organisms are destroyed. This destruction is done physically or chemically by the antibody combining with the antigen. When the animal has antibodies in its tissues and fluids and sufficient blood to stop the growth and invasion of a pathogen it is said to have immunity.

Where it happens

The primary sites of humoral antibody development are the liver and bone marrow. In young animals the thymus gland also is a producer. Lymphoid tissues such as tonsils and lymph nodes play less clear roles.

Interferon is a different type of antibody which blocks the entry of a virus into target cells. The production of this antibody is more rapid and works locally at the site of the infection.

What determines the degree of immunity?

The production of antibodies depends on:

1. The number of organisms (antigens) at the time of invasion.
2. The strength of the invader (i.e., virulent vs. low virulent strains of viruses).
3. The condition of the animal at the time of the invasion (sick animal vs. healthy animal).

How long does it take?

In general it takes about two weeks for a protective level of antibodies to be produced either in response to infection or vaccination. For this reason, vaccinating after a disease appears in a herd or flock is usually of little value and possibly may be harmful if the vaccine is live. There are a few exceptions to this rule, depending on how fast a particular disease spreads in a flock.

Types of Immunity

Passive immunity occurs without the active participation of the antibody production system of the immunized animal.

Two types of passive immunity:

Artificial: Blood serum from an immune animal contains antibodies which, when injected into another animal, makes the latter immune.

1. Mechanical transfer of immunity done by man, therefore, artificial.
2. Recipient plays no part, therefore, passive.
3. Antibody, not antigen, is transferred, recipient's immune system is not stimulated. Immunity will last only as long as the transferred antibody lasts (which could be from two weeks to 6 months).

Natural immunity is transferred from mother to offspring. This is done via the colostrum. Colostrum or first milk contains twice the total solids of normal milk and an excess of globulin which contains the same antibodies as found in the mother's blood. This is very important because the newborns have not yet developed their immune systems to produce their own antibodies. The newborn is able to absorb the antibodies intact--but this ability diminishes after 24 hours, and digestive processes destroy the antibodies. It is important that newborn animals receive colostrum as soon as possible after birth even if by hand feeding.

## Active Immunity

Active immunity occurs when the animal itself produces antibodies in response to antigens. The duration of active immunity may range from several months to a life-time, depending on the stimulative effect of the antigen involved.

Two types of active immunity:

1. Natural: When the animal is exposed to the disease and fully recovers.
2. Deliberate exposure: Antigens given through vaccination.

Active and passive immunities can complement each other.

The mother passes immunity via colostrum to her newborn; thus immunity is being developed because of natural exposure and infection. But if the pathogen is still in the environment, the offspring will be exposed. The offspring will not get the disease, however, because of the passive immunity. But as this immunity wears down, active immunity will develop through exposure. This will provide the long term protection after the passive immunity is gone.

## When is the best time to vaccinate?

Because passive immunity might interfere with antibody development from vaccines, it is generally best to immunize permanently by vaccine after most of the maternal antibodies are gone. This is usually at about six months. If vaccines are given before this they are:

1. Usually a milder strain because an animal's immune system is not fully developed but the animal needs immediate protection.
2. Part of a booster series of a gradual immune process.
3. Given because the animal needs the vaccine because of a potential outbreak in the immediate area, possibly with an antiserum.

## Types of Immunization Vaccines

1. Antiserum: Produced from whole blood from animals either exposed naturally or artifically to the disease. The antiserum contains a high percentage of globulin (the protein containing the antibody).

   Advantage: It produces immediate immunity when injected, so protection is provided very quickly (valuable when there is an epidemic in your area).

   Disadvantages:

   1. Duration of immunity is short.
   2. It does not stimulate immunity but merely passively transfers antibodies to the animal.
   3. It is quite perishable, expensive, species specific, and needs refrigeration.

2. Bacteria

   1. Suspension of killed pathogen bacteria, usually produced in an artifical medium.
   2. Method of getting a specific bacterial protein (antigen) into the animal without causing disease.
   3. Effectiveness depends on:

      a. Antigenicity of the organism.

      b. The number of killed organisms in the bacteria.

      c. Quality of the manufacturing process.

   4. Immunity rarely lasts over a year, and two or more doses may have to be given to yield satisfactory protection.

3. Vaccines

   1. This term is used for all immunizing agents but technically a vaccine is a product containing a living antigen.

   2. Most common vaccines are used against virus diseases in animal and man.

   3. Because viruses only survive in living tissue, production of vaccine is different from production of bacteria.

Types of vaccine

1. Modified live virus (MLV)

   a. Generally produce long lasting immunity.

   b. Because they are live they can cause illness.

   c. They are dangerous if given to weaker, stressed, diseased, or malnourished animals or those whose immune mechanisms are not developed.

   d. Use only when your animals are healthy.

   e. Use during the stage in life where economic loss will be minimized if the animals get sick (i.e., give vaccine when animals are not in production).

2. Attenuated vaccines are produced through a procedure in which the virus loses its virulence and capability of producing disease.

   a. Immunity is not as long lasting because the balance between antigenicity and attenuation shifts to the latter.

   b. There is less risk involved because the vaccine can not produce disease. It is not as hazardous to use.

3. Dead or killed virus vaccine

   a. Vaccine that cannot produce the disease but produces immunity.

   b. Degree of immunity less than attenuated or live virus vaccine.

   c. These usually have to be repeated every year to maintain a protective number of antibodies.

Vaccination is not a procedure which is 100% effective in preventing diseases.

Vaccines fail when:

1. They are improperly manufactured.

2. They are not properly refrigerated.

3. They are exposed to sunlight.

4. They are used after the expiration date.

5. They are improperly administered.

These problems are magnified in developing countries. Other problems one might encounter are:

1. The dosages are geared for large flocks because the country imports vaccines from developed countries where large flocks are common.

2. Dumping of expired vaccines by manufacturers on third would countries.

Methods of Administering Vaccines:

1. Intramuscular (IM) injection
2. Subcutaneous (SubQ) - under the skin between skin and muscle
3. Ocular: through the tear duct to the respiratory tract (eye dropper)
4. Nasal (eye dropper)
5. Oral
6. In the drinking water
7. By spraying/dusting (chicken houses) enclosed areas
8. Wingweb (chickens) injecting by stab in the wingweb
9. Feather follicle (chickens) using a cotton swab
10. Painting the anus
11. Intradermal: fine needle in skin (i.e., TB test)
12. Intraperitoneal: under the skin onto the fold of the abdomen (swine)

General Signs in Recognizing Disease

1. Sick animals usually isolate themselves from rest of flock or herd.
2. They look dull and are inactive.
3. They eat and drink less (this may be the first sign).
4. They grow slowly.
5. They produce less (eggs, weight gain, milk, & number of offspring).
6. Fertility may decline.

Specific signs of disease

1. Diarrhea
2. Paralysis
3. Coughing
4. Sneezing
5. Wheezing
6. Inflammatory exudate on skin
7. Blood in stools

If possible, it is good to send live sick animals to a veterinarian with the history of the animal. Decomposed animals are usually of little diagnostic value.

## Zoonoses

Zoonoses are those diseases whose causative agents are transmitted naturally between man and animal.

1. Over 100 zoonoses are recognized through the world.
2. These diseases are usually chronic in animals.
3. The symptoms are similar in man and animal.
4. Very little man to man or man to animal transmission of diseases occurs.
5. Man is often the dead end of the infection.

Some example of zoonoses are:

1. Rabies (virus)
2. Q fever & Rocky Mountain spotted fever (richettsial disease)
3. Brucellosis (undulant fever in man).- bacteria
4. Salmonellosis (bacteria)
5. Trichinosis (worm origin).

# VET KIT

When doing work in the field the materials listed below may be helpful. By planning ahead you can have these materials on hand when they are needed.

1. Cotton
2. Razor blades
3. Iodine (in a spray bottle if possible)
4. Alcohol
5. Scalpel
6. Knife
7. Disinfectant (chlorine)
8. Toe or fingernail clippers
9. Plastic or metal syringes
10. 16, 18, 20, 21, & 22 gauge needles
11. Merck Vet. Manual
12. Injectable drugs:
    - Tetracycline
    - Penn + Strep
    - Sulfa drugs
    - Dextrose or glucose with water
    - Topical dressing
    - Injectable iron
    - Vitamins and minerals
    - Tylosin
    - Erythromycin
    - Oxytocin
13. Other supplies
    - Vitamins/Minerals
    - Antibiotics
14. Anthelmintics
    - Piperazine
    - Thiabendazole
15. Needles and thread for sewing wounds
16. Needles for Fowl Pox vaccination
17. Equipment for keeping vaccines cold

18. Needle nose pliers

19. Hemostats

20. String or thick thread

21. Jar with alcohol to carry boiled needles in

22. Pan for boiling needles

23. Heavy rope

24. Plastic gloves

25. Face mask

26. Baby bottle for feeding baby pigs and goats

27. Powdered milk

## LIVESTOCK PRODUCTION PLANNING

Nutrition is the most important component of the 5 components that form livestock development. If a volunteer is working towards improving productivity in livestock production with small farmers then he or she must *first* work to improve the feeding of their animals. However, the volunteer often lacks the technical skills needed and an adequate knowledge of the community agricultural environment to know if an improvement in productivity is possible or desired by local farmers. We cannot over-emphasize the importance of working with local farmers in order to understand their husbandry practices, their reasons for their management decisions, and to gain knowledge of *local* conditions.

If productivity is to increase, there is a myriad of factors to consider, but nutrition and feeding are the first steps. The volunteer must conduct an exhaustive survey of all locally grown feeds. The volunteer should answer these questions: What are the animals fed currently? Is there an abundant supply all year round? Are there storage problems? What are the nutrient values of these feeds? Is it grown locally? What is the market value of the feed? Is there a surplus or shortage? Are there any other low cost, locally available feeds not currently being fed to animals? Why? When the volunteer has gathered complete information on every possible animal feed, then he or she should begin to balance feed rations. Try every possible combination in order to come up with as many profitable rations as possible. Since grain storage and transport may be a problem, one can not rely on a continuous supply of the same feed ingredients year round. Therefore different rations and feedstuffs will probably be used at different times of the year. If the volunteer finds a ration or rations that are inexpensive, available locally all year long, profitable for use by local farmers, appropriate for the local agricultural environment, not taking away needed grains from human consumption, matched to the 4 other components of livestock production on the developmental continuum, and accepted by the farmers as a good idea, then one can begin to work on improving *local* livestock production.

The next step is to become involved in a larger "community analysis" that includes infrastructure, available agricultural supplies, marketing, meat preservation, local climate, government policies & price controls, credit, pricing of meat and feeds, local taste in meat, and who will gain the most from the increased production. We will examine each of these points separately.

*Infrastructure*: Is there adequate shelter for the animals? How are the roads between you and your market? Passable year round? Is the transport you need available? How will transport cost effect profit? Is there adequate water for drinking by your larger herds? Are your animals on private land or public domain?

*Available Supplies*: Are the vaccines and antibiotics you need available? Are they prohibitively expensive, scarce, or of low quality? Is there a good hatchery in the area? Are there low cost laboratory testing and medicines available?

Marketing: Will you sell to local butchers or slaughter and sell the meat directly? Will it be sold in the village or taken to the regional markets? When is the most lucrative time to sell? Is the market controlled by middle men or women? If so, how does that effect profit?

Preservation: Will the animal be sold live or as meat? If as meat, how will it be preserved? Salted? Smoked? Eaten fresh? Frozen? Refrigerated? Sun dried? Be sensitive to local custom on this because people's culinary habits are not going to be changed by you and you could lose money for the farmers you are working with.

Local Climate: Expect the worst. What effect would a drought have on the production? Insect attacks? Excessive rainfall? Flooding? Crop failures?

Government policies and price controls: Are the cost of feeds or meat regulated? By whom? What are their policies? Will this efrect your profit? Are there government policies for quarantine during disease epidemics? Is there a local agricultural extension agent? Can he be of service to you or the local farmers you are working with? Does the government offer low interest agricultural loans?

Pricing of meats and feeds: Who sets the prices? Are you free to set your own? Can you make a profit based on current local prices of meat and feeds? (We will deal extensively with this question during our management planning classes.)

Local taste in meats: Is a dark, tougher meat preferred to a light, softer meat? Be sure to produce the type of meat with the flavor preferred locally and butchered in the local manner or people will not buy it.

Who will gain?: Finally, who in the community will gain the most from your work in increasing livestock production? What if you help the wealthy cattle rancher to increase his herd production and yet the price of beef makes it unavailable to the poor? Yet, can you help the poor who lack the land, feed, and other resources needed to improve livestock production?

Once you feel you have the answers to all of these questions and a clear understanding of local conditions, your two years will probably be done. However, if you have any time left, make sure you balance the production level of your feed ration (high, moderate, survival) with the production level of your herd or flock in genetics, diseases and parasites, management, and housing. We will discuss the balancing of the 5 components on the same production level at length in our management planning classes.

# LIVESTOCK PRODUCTION LEVELS

Volunteers will encounter a wide range of production levels for livestock with different farmers. These varying production levels will range from survival to moderate to high in regards to nutrition, management, housing, diseases and parasites, and genetics. The purpose of this handout is to begin to identify, for each of the 4 species, specific examples of the kind of conditions that comprise survival, moderate, or high level production environments. The examples given are meant to be "typical" of varying production levels. Every farmer's livestock operation will be different and these are meant only to be used as a general guide for the volunteer. It can also help the volunteer in determining when one of the five different categories of production is not on the same level with the others.

## Rabbit Production

### Survival Level

Nutrition

Fed only table scraps and vegetable wastes. Given contaminated water on an erratic basis.

Management

No improved practices at all. Given only the minimal care needed to keep the rabbits alive.

Housing

Both bucks and does are penned together on a dirt floor. No walls but there is a bamboo or palm thatch roof for shade.

Diseases and Parasites

Presence of two or more of the following: Coccidiosis, conjuctivitis, mange, ear mites, colds, or pneumonia.

Genetics

Creole varieties present - no improved (exotic) breeds.

### Moderate Level

Nutrition

Given clean water daily. Given good quality grasses and legumes for forage daily.

Management

Breeding records kept and ear tatooing practiced.

Housing

Rabbits caged in bamboo or wooden hutches. Bucks and does separated. Cages cleaned occassionally. Rabbits shielded from drafts and the hot sun.

Diseases and Parasites

No pneumonia, mange, or coccidiosis present. Animals appear to be healthy and gaining weight. Coccidiostat used when needed.

Genetics

Presence of exotic or improved breeds - probably crossed with local breeds.

## High Level

Nutrition

Vitamin and mineral supplement given ad lib. An adequate supply of fresh legumes and grain given daily. Fresh, clean water given twice daily.

Management

Meat production and breeding records kept. Ear tatooing. Fryers marketed at 8 weeks/4 pounds. Rabbits sexed, palpated, mated, and handled properly.

Housing

The cages have wire floors (1/2 grid), leak proof roof, kindling boxes, hay mangers, and automatic waterers. The cages are cleaned weekly. The rabbits receive morning sun and no drafts.

Diseases and Parasites

Disease and parasite free. The regular use of a coccidiostat and dipterex or malathion for mange.

Genetics

All exotic breeds adapted to the local conditions and market preference in meat and size.

## Poultry Production

## Survival Level

Nutrition

Scroungers, feed off of weed seeds, insects, manure, and table scraps. Probably drink contaminated water.

Management

No improved management practices used.

Housing

Free range - no housing provided. Perch in trees at night. Losses to predators.

Diseases and Parasites

Problems with both internal and external parasites. High mortality losses. Presence of both morbidity and mortality diseases such as Fowl Pox, Newcastle, Coryza, and Coccidiosis.

Genetics

All local varieties - no exotics.

## Moderate Level

Nutrition

Fed "scratch" feeds (low quality and percentage protein grains), table scraps, and starchy tubers. Given water daily.

Management

Wings clipped, coccidiostat used occassionally (during outbreak), home-made feeders and waterers used. Eggs collected daily.

Housing

Penned on a dirt floor with thatch roof & fenced walls of thorn, thatch, or wood.

Diseases and Parasites

No current outbreaks of mortality diseases though birds may be carriers. Possible coccidiosis or overall stress lowering production.

Genetics

Mixture of local breeds and exotics. Generally "dual purpose" birds for both meat and eggs.

## High Level

Nutrition

Ad-lib fed a complete, balanced ration adapted to the type of production (egg or meat), the age of the birds, and the cost of feeds locally. Includes a source of animal protein in the ration. Good supply of calcium. Fresh, clean water given daily.

Management

Light source used for layers, brooders used for chicks. Kept separate from other birds. Breeding stock from good hatchery. Eggs collected daily. Birds debeaked and production records kept daily.

Housing

Regular chicken coops using chicken wire and good roof. Perches and nesting boxes provided. No drafts, proper spacing requirements met. Automatic waterers and feeders used.

Diseases and Parasites

Disease vaccination schedule maintained for all major poultry diseases in the area. Birds are disease and parasite free. No known carriers in flock.

Genetics

All exotic breeds. Probably leghorn used for egg production. Heavier meat breeds used for broilers.

# Swine Production

## Survival Level

### Nutrition

Free range, scroungers. Diet consists of whatever is found in the streets - roots, feces, grass, and weeds. May be fed table scraps occasionally. Drinking water is probably contaminated by parasites.

### Management

Probably no improved management techniques are used. In Latin America a forked yoke is commonly used to keep the pig out of barbed wire fences.

### Housing

Free ranging during the day but may be placed in a compound at night.

### Diseases and Parasites

Roundworm, tapeworm, fleas, and ticks are common. Probably are carriers of diseases such as brucellosis, hog cholera, African swine fever, and others. High mortality losses.

### Genetics

No exotic breeds - all locally adapted breeds. Street pigs.

## Moderate Level

### Nutrition

Fed starchy tubers such as cassava, taro, yams, or potatoes, table scraps, and occasionally small amounts of corn or other low protein grains. Watered daily.

### Management

Given deworming medicine occassionally, boars castrated, and sows still unassisted at farrowings. Ear may be notched or some marking present to indicate ownership.

### Housing

Hog is penned and has a mud "wallow" to use for cooling down during the heat of the day. Possible shade from trees, and a dirt floor. Both sexes are still housed together.

### Diseases and Parasites

No current outbreaks of the major mortality diseases. Some morbidity diseases, internal and external parasites still present, producing stress on the animal and lowering feed conversion and weight gain. May or may not be carriers of disease.

### Genetics

Mixture of local varieties and improved breeding stock. No control over breeding.

## High Level

Nutrition

Fed a high production feed ration that meets the NRC requirements for ME, CP, Lysine, Calcium, and Phosphorus. Clean, fresh water and feed available ad-lib.

Management

Production and breeding records kept. Farrowing crate used during farrowing, sow assisted during farrowing, piglet cords dipped with iodine, iron shots given, and needle teeth clipped. Boars are castrated and all pigs dewormed on a regular schedule.

Housing

They are penned on a cement floor. Farrowing crates, dirt runways, and pastures are used. Automatic waterers and feeders are used and they are kept dry by a good roof.

Diseases and Parasites

Disease and parasite free stock. A regular vaccination schedule is followed.

Genetics

All exotic breeding stock used to obtain a 3 way cross in meat hogs for hybrid vigor.

# Goat Production

## Survival Level

Nutrition

Goats fed on overgrazed, unfertilized grass pasture of poor nutritional value. Given no protein, vitamin, or mineral supplements. Water may be in short supply and is probably contaminated with parasites.

Management

No improved management practices. Goats used for meat only - not milk.

Housing

Days spent foraging on pasture - may or may not be placed in the compound at night.

Diseases and Parasites

Brucellosis, mastitis, or mile fever may be present. Probable infestation of roundworms, coccidiosis, lice, and/or mange.

Genetics

All local breeds adapted to poor feeds - non milkers.

## Moderate Level

### Nutrition

Fed on pastures of improved varieties that are rotated regularly and not overgrazed. Occasionally grazed on legume crops. Adequate water supply but may be contaminated with parasites.

### Management

Goats are milked daily. Does with severe mastitis or brucellosis are treated or culled. Treated for both internal and external parasites - but not regularly.

### Housing

Animals are rotated on different pastures during the day and kept in the compound at night to prevent predator losses.

### Diseases and Parasites

Herd may still be carriers of disease even though there are no current outbreaks. Parasites a problem still - but not severe due to an occasional treatment.

### Genetics

Mixture of local breeds and exotic stock. Dual purpose animals for both meat & milk.

## High Level

### Nutrition

Goats are fed high quality legumes and grazed on improved and fertilized pastures. Grains and a vitamin and mineral supplement fed to the milking does. Ad-lib fresh and pure water.

### Management

Dehorning, castration, and hoof trimming are practiced. Milking stalls used and does milked twice daily. A regular vaccination schedule is followed for all major diseases in the area. Production and breeding records are kept.

### Housing

Bucks and kids are grazed during the day and penned at night. Does remain penned all the time and feed brought to them. Barn has a dirt floor and a roof for shade. The barn contains individual stalls with bedding and individual stanchions for milking.

### Diseases and Parasites

Disease and parasite free herd. Treated when necessary for mastitis and roundworms. All new stock is kept separated from herd until it is sure that they are disease free.

### Genetics

Improved, exotic stock such as Nubians or Toggenburgs.

# THE PITS!

Listed below are 7 common pitfalls that volunteers in livestock production often encounter. In an attempt to keep all of you out of the pits (some of which we found ourselves in), we are listing these. Our intent is to get your curiosity going and get you to thinking, since we can not provide answers that we do not have. We will take time in class to discuss these points.

1. They attempt to improve livestock production without improving the diet of the animal. Grave mistake.

2. They introduce improved (exotic) breeding stock that have been bred for high production into survival production environments.

3. They do demonstration work with livestock through different institutions (such as schools or 4H clubs) and base their project on shielded, false economies that a farmer can not duplicate since he or she does not have the same resources. The alternative is to work in real development with farmers.

4. They place their projects into direct competition with humans by feeding grains to animals in villages where the people lack protein.

5. They start to work too soon - before they gain understanding of local culture, language, and the agricultural environment of their village. This can produce disaster.

6. They do not match all 5 components of livestock production (nutrition, management, diseases and parasites, housing, and genetics) at the same level of production.

7. They assume that an increase in production is always possible. Furthermore, they forget that the first objective of the small farmer is not to maximize production, but rather for the animal to survive.

## SAMPLE LIVESTOCK PRODUCTION SCENARIO

### Swine

You arrive at Nkunda's house at the 110th day of gestation of one of her sows. She tells you that the following will be done after farrowing: The sow will be fed 10 cans of corn and 1/2 can of soybean meal, teats will be rubbed to stimulate milk flow, and her son will bring water twice a day. You observe that the pigpen has a loosely spaced bamboo floor, thatched walls, and a roof. She tells you that the sow has been fed 4 kilograms of corn daily during gestation.

A. List all the necessary imputs you must make within the next few days.

B. Nkunda's son works with the sow while she farrows and 6 piglets are born. Eight hours after farrowing three have diarrhea and three of the sow's teats are reddish with clotted milk.

   1. List all possible diseases present.

   2. List all necessary inputs you must make to alleviate the situation.

   3. If the diarrhea persists, after the treatment, will you adjust her lactation ration? If yes, what is the adjusted ration?

### Goats

You are in a small village with some "large scale" farmers who grow corn, soybeans, and rice for commercial purposes. There is a brewery in a nearby town and a rice processing plant in yet a third town. The majority of people are subsistence farmers growing manioc, corn, peanuts, and beans. Quite a few have goats and have problems with weight loss, high kid mortality (after birth), ticks and internal parasites during the dry season. They give no supplements to the goats at any time. They are watered once a day and staked out, then returned inside the compound at night. In the rainy season, there are often outbreaks of high mortality diseases, and very few vaccines available or technicians who know how to use them or manage animals. In view of these problems, the host country government wants to introduce some improved breeds to upgrade the common goat and produce more milk. These exotic breeds of goats will be vaccinated against the common high mortality diseases.

1. At what production level are the farmers with regard to goats? Why?

2. What recommendations would you make to them to improve their situation? Use nutrition, diseases and parasites, management, genetics, and housing as the framework to your answer.

3. What benefits do you see in the government's project?

4. What shortcomings do you see in the project?

5. Would you be in favor of the project? Why or why not?

## Rabbits

1. You have just completed the first year in Luebo. You have a rabbit project just starting with 3 New Zealand does and one New Zealand buck. The rainy season has returned and the grazing area of grasses is beginning to grow. You believe that you have no major disease problems and you do have good wire cages to use. It is your plan to make the project labor intensive and utilize the labor of the local school kids. You have arranged to purchase on credit 2,000 pounds of corn and 400 pounds of winged beans from a local cooperative. The corn costs 10¢ per pound and the winged beans 20¢ per pound. You also have access to vitamin and mineral supplements and an adequate supply of limestone.

   A. Based on this information prepare a feed ration for your rabbits.

   B. What is the cost of the ration per pound?

   C. What management problems (only two) do you foresee based on the information?

   D. What feed/gain ratio can you expect?

   E. How many fryers will you be able to market with this volume of feed? State your reasoning. How many months will it take to produce your market number of fryers?

   F. What price per pound must your rabbits sell for you to realize a reasonable profit?

## Poultry - Broilers

After losing your dashiki raising egg layers in Africa, you get involved in a broiler project. You successfully raise 100 broilers up to 8 weeks and each bird weighs 3 pounds. You have fed the 100 broilers a total of 800 pounds of feed which cost $.10 a pound.

A. What was your feed conversion to produce one pound of chicken live weight?

B. In regard to feed cost, how much did it cost to produce one pound of meat live weight?

C. If feed is 75% of your cost, how much would you have to sell a pound of chicken live weight for in order to break even?

## Poultry - Layers

You visit a school poultry project that you help set up. After a frustrating but fruitful effort they are keeping records on their chickens. At the end of the month of September their 100 White Leghorn layers had consumed 1000 pounds of feed, and produced 150 dozen eggs. As part of a business project the students are selling the eggs back to the school. The cost of the ready mixed feed is $12 for 100 pounds and the eggs are selling for $1 a dozen. Determine:

1. Total feed consumed per bird for that month.
2. Total egg production per bird for that month.
3. Daily feed consumption per bird.
4. Percent production for that month.
5. How much feed to produce a dozen eggs.
6. Considering only feed cost, profit per bird for that month.
7. How would you rate their feed to dozen eggs to the average optimum condition for White Leghorns?
8. Would you expect egg production to rise or fall? Why?
9. To increase their profit what factors might you attempt to change in the management of their flock?

# SMALL ANIMAL PRODUCTION ASSESSMENT TOOL

1. Introduction
2. Assessment Questions
3. Some specific considerations for raising poultry, rabbits, swine, goats, and bees

## Introduction

Because of the potential for longterm effect on community nutrition and economy, small-scale animal production can be projects which are among the most satisfying of Volunteer activities.

The Small Animal Production Resource Packet should help you decide on the best animal project for your community. Your personal preferences should also be considered, of course. But the key to long-range success with your project is a combination of two basic points: 1) the project must meet local needs, and 2) it must achieve local support.

Choosing the project that will have the most positive impact will require careful observation, endless legwork, and nonstop questioning. This assessment tool raises basic issues and suggests some key questions to help you direct your investigation.

There are many variables to consider when deciding on an animal project, especially in a Third World context. Your position in your community and the opportunity to observe over time gives you an important advantage in judging the feasibility of the project. Your example and influence can have immediate and long-range impact. You may become involved in improving local stock, or you may try to introduce new animals or new uses for existing protein sources. Concentrate on making sure the project is intrinsically viable and valuable to the local target group. The adage, "Give me a fish and I eat for one day. Teach me to fish and I'll eat every day," is particularly appropriate to small animal projects. A logical and vital addendum is "Teach a mother and you teach a whole family." Do not ignore the long-range impact that your work may have on women. The linkage to health and nutrition programs, to cooperatives, and to other forms of economic development could be very effective.

## TIPS ON INFORMATION GATHERING

Information gathering techniques are covered completely in Community, Culture, and Care, by Ann Templeton Brownlee (available through ICE) but in very general terms:

1. Gather your information firsthand.

2. Ask many different sources to develop a wide network of contacts and an overall picture.

3. Concentrate on cultural similarities, not differences.

4. Ask questions that get people thinking in a positive way.

# ASSESSMENT QUESTIONS

## Rationale

Note: When a project meets local needs and achieves local support, it will be considered successful and become self-perpetuating.

Why do you want to attempt a small animal project?

What community needs will be fulfilled?

What factors in the community point to the success or failure of a particular animal project?

## Site

Note: Being thoroughly familiar with a community and its problems will ensure a sensitive approach to meeting the needs of the local population.

What climatic/seasonal factors, such as ranges in temperature, rainfall, humidity, food or water shortages, etc., may have an impact on small animal projects?

What local or country-wide policies might have an impact on the project?

What predators or insects might have a negative impact on the project?

## People

Note: Understanding the cultural and work patterns in the community will provide insight into how best to achieve an effective program.

Who is the target group? Is that group likely to support a small animal project? Why or Why not?

Who is likely to support the project? For what reasons?

Who will benefit? In what ways? Will that insure long-term success?

Who are the traditional animal raisers? Why? What are the time constraints on this group?

Who are the influential economic leaders in the community?

How will the family or community structure be affected?

What local conditions, such as religious beliefs, migration patterns, etc., might help or hinder this project?

## Economics

Note: An animal project that is income-generating is very likely to succeed.

What is the basic type of economy in the area (e.g., agriculture, pastoral, semi-industrial, etc.)?

What is the level of development of that economy? What are the strains on the local economy (e.g., crop failures, poor marketing system, etc.)?

What are the time and work requirements of the target group?

What is the average income level of the target group (or level of the source of money of the target group)?

What amount of capital outlay for projects could most members afford easily? What strains will small economic gains or losses have?

## Animal

Note: A thorough investigation of the level and scope of the production of existing animals will uncover many factors that may limit or enhance success.

What is the quality of the existing local stock? Is there potential for improving that stock through cross-breeding?

How and where are these animals raised? (e.g., run loose, in cages, pens)

Under what conditions are they raised? Is there adequate food, water, sanitation?

Why are these animals raised? (e.g., for food, sources of ready cash, for gifts, for special occasions, investment, important by-products, etc.)

Why aren't certain animals raised? Are there any special beliefs, rules, preferences, or prejudices concerning food from certain animals? Foods that various categories of people should or should not eat? Times when and ways in which certain foods should or should not be eaten? Special ways in which food should or should not be prepared? Foods believed to cause sickness or misfortune, separately or in certain combinations?

Do the local people eat the animals they produce?

Do they sell the animals? Where?

## Animal Food and Water Supply

Note: The limiting factor in most animal projects is the non-availability of animal feed.

What food crops are easily available?

What could be fed to animals?

What do local people use to feed their animals?

Are bulk purchases of animal food possible?

Are special concentrates, vitamins, or mineral supplements easily available? Affordable?

Is clean, fresh water easily available?

Are salt blocks available?

## Markets

Note: Access to markets is an important consideration.

What outlets or markets are accessible?

What demand would there be for any animal or food product locally?

What potential markets exist for by-products?

What preferences in purchasing do marketers demonstrate (i.e., lean meat, fatty meat)?

What shipping and sanitation problems need to be addressed if distant markets are to be feasible?

## Local Technical Support

Note: Technical advice from experienced local people will help prevent costly problems.

Who could be a resource person for technical advice (i.e., Agriculture extension agent, veterinarian, experienced animal raiser, teacher, AID specialist)?

Who is attempting a similar project? Is it possible to collaborate?

Has a similar project been tried unsuccessfully? What were the reasons for the failure?

Who can give a demonstration of practices and techniques that have been successful in that locale?

Who can supply healthy breeding stocks?

What organizations in your country are involved in similar projects?

What government support is available for subsidies, if necessary?

## Personal Traits and Biases

Note: Consider your personal motivation in starting a small animal project.

What kinds of personal experience with animals do you have to draw upon (e.g., pets, farm background, school projects, part-time work)?

Will you enjoy caring for small animals?

Carrying water? Locating food supplies?

Building shelters?

Fighting diseases?

Fighting predators?

Doing clean-up?

Slaughtering?

Are you a good manager? Will you be responsible for the feeding, breeding, and record-keeping of your animals?

Can you instill that responsibility in your target group?

When it comes time for slaughter, will you be able to do demonstrations? Will you be able to prepare the food and promote its value to others?

Are you willing to do a limited backyard project on your own to test out your choice of animal?

Are you willing to invest the time in answering all the assessment questions?

## Long-range Impact

Consider the possible long-range benefits or liabilities in your planning.

| Likely Benefits | Possible Liabilities |
|---|---|
| Increased source of protein | Negative environmental impact |
| Cash source | Negative cultural impact |
| Higher yield through improved management techniques | Financial risk |
| Source of by-products | Time commitment (for you and the local animal raisers) |
| Labor intensive | |

# SOME SPECIAL CONSIDERATIONS FOR POULTRY, RABBITS, SWINE, GOATS, BEES

## POULTRY

| Positive Considerations | Possible Problems |
|---|---|
| Diet supplement and/or cash source. | Poor management techniques are common. |
| Possible to raise meat birds or layers. | Poor breeds hamper good production. |
| Rich fertilizer by-product can be collected easily if housing exists. | Securing adequate feed and supplements may be difficult. |
| Possible to cultivate and use grain not consumed by humans for feed. | Capital investment for housing, especially for small producers, is sometimes economically unfeasible. |
| Benefits (better nutrition, extra income) are easily seen. | Chicken are very disease-prone. |
| | Chicken-raising is looked down on in some cultures/communities. |
| | Eggs are sometimes taboo. |

Suggestions:

Observe market supply and demand; identify peak periods. Ascertain what causes these fluctuations.

Locate housing or materials for construction. Housing is a definite aid to disease control.

Decide on an emphasis of production. Meat birds (broilers) can be marketed in ten to twelve weeks. Layers can begin production after twenty weeks.

Be sure that any project is economically feasible from the producer's point of view.

## RABBITS

| Positive Considerations | Possible Problems |
|---|---|
| Easy to raise.<br>Small start up cost. | Not widely accepted as a food source. |
| | (Note: countries with cultural heritage connections to France or Italy might be good choices) |

Excellent protein source; tastes like chicken.

High reproduction rate.

Source of several by-products:

- excrement can be used as fertilizer, as fuel for methane digester, or as home for earthworm production.
- skin and paws can be used in tanning projects and for crafts production

Labor intensive if all by-products are used.

4-H or school project potential: including shows, competitions, or providing source of food for students.

If a local person is already involved, many initial problems have already been raised and solved.

Housing is a must.

Need constant human care: clean water, grain, greens.

High temperatures may affect production.

Environmental impact of escaped animals may be severe.

Suggestions:

Conduct intensive background research. Locate a committed, involved local rabbit raiser.

Breed selection is important for maximum production. Try to obtain rabbits from stock that are consistent producers of 6-8 rabbits a litter.

Be sure and locate reliable feed source before starting.

# SMALL ANIMALS PRODUCTION
# RESOURCE PACKET
# BIBLIOGRAPHY

## RABBITS

The Rabbit as a Producer of Meat and Skins in Developing Countries by J. E. Owen, D. J. Morgan, and J. Barlow; 34 pp., 1977. Tropical Products Institute, 56/62 Gray's Inn Road. London WCIX8LU; .90 pounds.

Prepared by the Tropical Products Institute of the British government development organization. Brief assessment of the state of production in several tropical regions, especially concerning the effects of tropical temperatures on production, and the possible impact of escaped animals. Lists persons heading rabbit research projects in developing countries. (Summary and conclusions in French and Spanish).

Available to PCVs through ICE.

Raising Rabbits by Harlan H. D. Attfield, 90 pp., 1979. (Also available in French) VITA, 3706 Rhode Island Ave., Mt. Rainier, Md. 20822; $2.95.

Covers basic aspects of rabbit raising for developing countries without a specific regional orientation. Including detailed hutch construction illustrations.

Available to PCVs through ICE.

Raising Rabbits the Modern Way by Bob Bennett, 158 pp., 1975. Garden Way Publishing, Charlotte, VT., 05445; $4.95.

Basic, practical U.S.-oriented guide, geared to the small-scale, backyard producer. Small section on rabbit clubs and shows.

Not available through ICE.

## SWINE

### Positive Considerations

Small-scale project can be low-risk and short-term but show impressive gains. Model projects can have a big impact on production techniques.

All parts of the pig can be eaten or used.

### Possible Problems

Religious beliefs make hog production unacceptable to some areas.

Availability of proper feed is crucial for best production. Corn is best but the by-products of other grains are also possible.

Hogs are disease-prone; internal parasites are common; innoculations are necessary. An agriculture extention agent or veterinarian needs to be involved to prevent losses through disease.

Male pigs need to be castrated to produce meat of better flavor. This may be culturally unacceptable.

Meat can cause illness if not thoroughly cooked or cured.

Hogs need a salt supply and vitamin/mineral additives to basic rations.

Suggestions:

Keep project small. Financial risks are high due to the high costs of foundation stock.

Build a demonstration farrowing stall to show simple technique and positive impact on production.

# SMALL ANIMAL PRODUCTION
# RESOURCE PACKET
# BIBLIOGRAPHY

## SWINE

Small-Scale Pig Raising by Dirk van Loon, 263 pp., 1978. Garden Way Publishing, Charlotte, VT., 05445; $5.95.

Geared to backyard operations of one or two hogs. Emphasizes feeders, farrowing, nutritional needs, and management techniques.

Available to PCVs through ICE.

Swine Science by M. E. Ensminger, 692 pp., 1961. Interstate Printers and Publishers, 1927 N. Jackson St. Danville, Ill.; $13.50.

In-depth technical reference text on all aspects of swine production. Written by the outstanding authority on animal science in the United States.

Up to 2 copies available to PC in-country libraries through ICE.

Basic Principles of Hog Production Adapted to Panama, by James McGrann, 43 pp. Peace Corps report with recommendations for successful hog production in the tropics. Suggestions for alternative feeds, with management tips on breeding techniques.

Available to PCVs through ICE.

## GOATS

### Positive Considerations

Easy to raise.

Relatively disease free.

Good source of meat, milk, and cheese.

Feeding habits help clear land of vegetation. (However, note first Problem).

By-products include kid skin, fertilizer, and wool.

### Possible Problems

Goats need vegetation for "browsing"; can cause serious destruction of rangeland.

Confining goats is difficult, but they should be fenced to prevent damage to gardens and crops, or fence the gardens.

Housing is usually recommended for protection at night.

Goat raising is looked down on in some cultures/communities.

### Suggestions:

Consider raising goats in small fenced corral and bringing feed to them. This allows both control and eliminates danger. If milk production is key objective, the quality of feed and breed selection become even more important.

## SMALL ANIMAL PRODUCTION
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## BIBLIOGRAPHY

### GOATS

Aids to Goatkeeping, compiled by Kent Leach, 277 pp., 1975. Dairy Goat Journal, P.O. Box 1908, Scottsdale, AZ., 85252; $10.00.

Basic aspects of U.S.-based goat raising, with emphasis on dairy-goat production.

Available to PCVs through ICE.

Raising Milk Goats the Modern Way by Jerry Belanger, 152 pp., Garden Way Publishing, Charlotte, VT. 05445; $4.95.

Prepared by the editor of Countryside and Small Stock Journal, with small-scale, backyard approach to goat raising. Basic information for beginners and new management techniques for those with experience.

Not available through ICE.

# FARM VISITS

Farm visits are important in livestock training because they afford certain opportunities to the trainees that can not be replicated at the training site. You can learn local farming practices firsthand through observation and participation. Furthermore, it presents the opportunity to meet local farmers and to learn from them such points as use of local resources, marketing, climate, cost of feeds, local breeds, housing, local disease and parasite problems, etc. In seeking out this information, you can practice the skills taught in Core sessions. Listed below are examples of some of the Core skills that can be practiced during a farm visit.

I. Communications Skills
  - Appropriate use of language
  - Listening

II. Community Analysis
  - Information filtering
  - Identifying farmer self interest and motivation

III. Agricultural Extension
  - Dialogue
  - Method-demonstrations to farmers

Trainees can also practice the technical "hands-on" skills learned in livestock training under field conditions. Experience and practice are 2 fine teachers that can be learned from in these visits. Furthermore, work in the field removes the classroom atmosphere of a training site and allows trainees to practice the skill or skills that can commonly be practiced in the field. The list is not all inclusive and will vary during different seasons and in different countries.

- Treatment for internal and external parasites
- Castration
- Iron shots
- Vaccinations
- Hoof trimming
- Vitamin injections
- Ear tatooing
- Wing clipping
- Culling

During farm visits it is important that you, as a trainee to become a development worker in agriculture, assume the role of active participant rather than as a passive observer. Since successful extension work often requires such participation as a means of explaining a new technique in-country it is good to start practicing the method in training. Do not be afraid to soil your hands. However, if you are practicing a technique or skill with a farmer's animals you must be careful not to injure or kill the animal. Do not practice a technique that runs this risk without the farmer knowing of the risk and the trainee must have the necessary funds to compensate the farmer for any loss. Hands-on skills are best learned through practice. Therefore, any farm visit that limits you to simple observation is of limited value.

When and where possible it is a good idea for the trainees to organize the farm visit. By doing so you will be gaining agricultural extension experience and if you work in extension in your host country you may wish to organize your own farmer visits. The contacts you make during your live-in with your family and other farmers or neighbors might yield potential farm visits. Furthermore, the local agricultural extension service might be willing to work with you and the farmers in organizing farm visits. While organizing to do a farm visit, you should consider the following points while planning the activity.

1. The timely nature of the visit.

   By this I mean that you should choose a time with the farmer that is convenient for both of you. Furthermore, after exploring with the farmer the tasks for the trainees to accomplish, you should ensure that (supposing the work to be done is dusting of chickens for mites) indeed the poultry do have mites and that the trainees have practiced the skill at least once before the farm visit. The more realistic the visit is to a "real" agricultural extension visit with a farmer the more valuable it will be.

2. Receptivity of the farmer to you and your questions.

   It is always a good idea to make sure that your visit is timed so that the farmer can be present. If you anticipate the group asking many questions it is good to let the farmer know that ahead of time so he or she will feel more comfortable with the group. If you sense a limit on the farmer's time or receptivity to questions the group should be informed before the visit.

3. Are there any physical tasks to perform? If so, what are they?

   Here it is important to ensure that all the needed supplies for the work are on hand during the visit. Discuss with the farmer what you need to supply and what materials he or she will provide. Other considerations are:

   1. Do the trainees have all the needed skills and resources in order to do the work?

   2. Is the farmer's operation and level of production comparable to those the trainees will be working with in-country?

   3. Does the farmer have on his or her farm the same species of animals commonly found in-country?

   4. What constraints has the farmer placed on the group in working with his or her animals?

Finally, as the organizer of this visit, you need to work out all the details about transporting the group to the farm and the hour of the visit. Transport and timing are important to farm visits in stateside training but are critical items during an in-country training. For in-country training it is important to remember to be patient when the lorry does not arrive to transport you or when you arrive at the farm and the farmer is either late or not present at all. During training as well as during volunteer service it is always a good idea to have a contingency plan so that time is not wasted if the visit does not go as planned. Leave enough flexibility in your plans to take full advantage of unplanned opportunities as they arise. Remember that the farm visit is designed not only to practice technical skills but also to work on the Core skills as well.

# Farmer Livestock Survey

1. Farmer's Name Date:

2. Location

## Nutrition

3. List all available commercial animal feeds. Give price and source.

| | Animal Feed | Price/kg. | Quantity | Source |
|---|---|---|---|---|
| Chicken | | | | |
| Swine | | | | |
| Rabbit | | | | |
| Goat | | | | |

4. Available noncommercial feeds

| | Feeds | Season Available | Price | Source |
|---|---|---|---|---|
| 1. | | | | |
| 2. | | | | |
| 3. | | | | |
| 4. | | | | |
| 5. | | | | |
| 6. | | | | |
| 7. | | | | |
| 8. | | | | |
| 9. | | | | |
| 10. | | | | |

5. Are the animals free ranging or pasture fed? If so, then answer the following.

   a. Are the pastures native or tame?
   b. Are they fertilized?
   c. What are the common grass species?
   d. What are the common legume species?

6. What is the source of water for the following animals? Is it given ad-lib? Is it contaminated with parasites?

| Chickens | Swine | Rabbits | Goats |
|---|---|---|---|

7. How is animal feed stored currently?

8. What kind of feeding and watering equipment is used?

9. If the animals are fed commercial feed, then list out all the ingredients in ration for:

| Poultry | Rabbits | Swine | Goats |
|---|---|---|---|

## Management

10. Animals fed and watered:

Daily? Occasionally?

11. Are the following practices followed?

A. Poultry

- Egg collection
- Culling
- Feather clipping
- Debeaking
- Isolation of the sick
- Cleaning of cages or pens
- Waterers and feeders used
- Light source
- Litter management
- Parasite control
- Use of nesting boxes & roosting perches
- Natural or artificial incubation
- Forced molting

B. Swine

- Iron shots
- Teeth clipping
- Castration
- Navel dipping
- Farrowing crate
- Controlled breeding
- Tail docking
- Ear notching
- Control of parasites
  - Internal
  - External
- Piglets wiped off at birth

C. Rabbits

- Breeding records kept
- Ear tatooing
- Treatment for parasites
- Use of kindling boxes
- Controlled breedings
- Culling & selection
- Palpation of does
- Sexing of fryers

D. Goats

- Hoof trimming
- Castration
- Pasture rotation
- Diet supplements
- Treatment for parasites
- Controlled breedings
- Milking
- Tethering
- Kids wiped off at birth

12. Brief evaluation of the livestock extension services of the government in your village.

13. Average number of extension visits to this farmer yearly.

14. Are his or her animals exposed to the following stress factors:

- Disturbances
- Feed changes
- Caretaker changes
- Violent weather
- Movement
- Heat and humidity
- Poor ventilation
- Predators

## Diseases and Parasites

15. Estimate or name all the livestock disease outbreaks and the month of occurance.

| | Name or description | Month |
|---|---|---|
| 1. | | |
| 2. | | |
| 3. | | |
| 4. | | |
| 5. | | |
| 6. | | |
| 7. | | |
| 8. | | |
| 9. | | |
| 10. | | |

16. Available antibiotics and vaccines.

| | Antibiotic | Price | Sources |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |

| 17. | Vaccine | Price | Sources |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |

18. Are these vaccines administered regularly? If so, by whom?

    a. Newcastle
    b. Fowl Pox
    c. Fowl Cholera
    d. Hog Cholera
    e. Brucellosis
    f. Rhinderpest
    g. Hemorrhagic Septicemia

    Also, is a coccidiostat used regularly?

19. Are abortions a regular occurance with:

    Does (Rabbit)            How about cannibalism?
    Sows
    Does (Goats)

## Genetics

20. Number of:

| | Native | Breeds Crosses | Exotics |
|---|---|---|---|
| Chickens: | | | |
| Goats: | | | |
| Rabbits: | | | |
| Ducks: | | | |
| Swine: | | | |

21. Age of animals.

Poultry
Swine
Goats
Rabbits

22. List all breeds for each species:

**Exotics:**

Chickens
Swine
Rabbits
Goats
Ducks

23.

| Species | Exotics | Crosses | Natives |
|---|---|---|---|
| Breeding boars | | | |
| Breeding rabbit bucks | | | |
| Breeding goat bucks | | | |
| Breeding roosters | | | |

24. Hatchery information

a. Prices
b. Quality
c Distance to and from your village
d. Breeds used

25. Where does farmer buy new animals?

26. By species, which is more common: inbreeding or crossbreeding?

| | |
|---|---|
| Swine | Rabbits |
| Goats | Poultry |

27. Does the farmer use natural or artificial incubation?

28. Average litter size for:

| | |
|---|---|
| Rabbits | Swine |

29. Average age at puberty of:

Gilts
Rabbit does
Goat does
Hens

30. Average time to point of lay for poultry.

## Housing

31. Briefly list common animal housing materials and their respective prices.

| Materials | Price per Unit |
|---|---|

32. Briefly describe the typical housing design for:

Chickens
Rabbits

Swine
Goats

33. Estimate the percentage of each species population which is housed.

Poultry % ______ Swine % ______ Rabbits % ______ Goats % _____

## Marketing

34. Average number of eggs/chickens/week during maximum laying period?

35. Average time to market weight:

Meat hogs _______ Broilers _______ Rabbits _______ Goats _______

36. Average market weight in Kgs.

Meat hogs _______ Broilers _______ Rabbits _______ Goats _______

37. Average price per: kilogram, head, or egg:

Chickens eggs _____ Duck eggs _____ Meat hogs _____ Rabbits _____

38. Number of species population sold yearly:

Swine _______ Rabbits _______ Goats _______ Broilers _______

Consumed but not sold yearly

Swine _______ Rabbits _______ Goats _______ Broilers _______

39. Does farmer meat supply meet family needs?

40. Does the farmer export meat? Import meat?

41. What is the distance to the nearest livestock selling market?

Live or slaughtered?
Is the road to market passable year round?
If there is no road, are there other means of transport available?

| Means of Transport | Adequate | Cost |
|---|---|---|

42. Is there a consumer preference and price difference for the following?

| | Yes | No | If yes, what color? | Price difference |
|---|---|---|---|---|
| Color of eggs | | | | |
| Color of broilers | | | | |
| Color of meat hogs | | | | |
| Color of rabbits | | | | |
| Color of goats | | | | |

Preference for a fat carcass in chickens? Hogs?

Rabbits? Ducks? Goats?

Preference for castrated males for meat?

# SWINE NUTRITION

Swine in many countries of the world are considered a "dirty" animal because in free range environments they eat primarily garbage and feces. Any attempts to alter this free range environment would involve confining the swine and feeding them. Since 70 to 90% of the cost of raising pork is feed, volunteers must work to provide as inexpensive a ration as is possible and appropriate to the farmer's production level. Furthermore, good feeds can reduce the stress level on a pig and improve its health. The nutrient needs of swine are influenced by age, function, disease level, nutrient interaction, environment, etc.

## Nutrients

1. Energy is supplied mainly by two types of carbohyrates for swine. These are:

   a. Nitrogen free Extract (NFE). This includes the soluble carbohydrates such as sugars and starches and is highly digestible. Examples include corn, sorghum, manioc, & taro.

   b. Crude Fiber such as lignin and cellulose. These are highly indigestible for swine. Examples include overripe hays, straw, and grain hulls.

## II. Protein

Although it is common practice to refer to "percent protein" in a ration, this term has little significance in swine nutrition unless there is information about the amino acids present. For swine, quality is just as important as quantity. It is possible for pigs to perform better on a 12% protein ration, well balanced for amino acids, than on a 16% ration with a poor amino acid balance.

### Essential Amino Acids

Arginine
Histidine
Isoleucine
Leucine
Lysine
Methionine
Phenylalanine
Threonine
Tryptophan
Valine

### Non Essential Amino Acids

Alanine
Aspartic acid
Asparagine
Cysteine
Cystine
Glutamic acid
Glutamine
Glycine
Hydroxyproline
Proline
Serine
Tyrosine

Symptoms of protein (amino acid) deficiency are:

1. Reduced feed intake

2. Stunted growth

3. Poor hair and skin condition

4. Lowered production

## III. Minerals

Of all common farm animals, the pig is most likely to suffer from mineral deficiencies. This is due to the following peculiarities of swine husbandry:

1. Hogs are fed cereal grains and their by-products (as well as garbage and feces), all of which are relatively low in mineral matter, particularly calcium.

2. The skeleton of the pig supports greater weight in proportion to its size than that of any other farm animal.

3. Hogs do not normally consume great amounts of roughage (pasture or dry forage), which would tend to balance the mineral deficiencies of grains.

4. Hogs reproduce at a younger age than other classes of livestock. For additional information on specific minerals refer to the charts that are included in your guidelines.

## IV. Vitamins

Refer to the charts.

## V. Water

The daily water requirements of swine vary from 1/2 gallon to 1 1/2 gallons per 100 pounds of liveweight. The higher requirements are for young pigs and lactating sows. Also, the higher the temperature the greater the water consumption. Remember too that many of the fecally spread, water born parasites that effect humans have swine for their intermediate host. Therefore, humans and swine should not share the source of water.

## Feeding Practices for Different Classes of Swine

### 1. Breeding Gilts

Prospective breeding gilts should be kept from getting too fat. This can be a problem in moderate level production where the ration of the animal may be too high in carbohydrates and too low in protein. Meat-type hogs can usually be left on a high-energy ration until they reach 175 to 200 pounds without becoming too fat. It is neither desirable nor necessary that females intended for breeding purposes carry the same degree of finish as market animals. After selecting replacement gilts, they should be fed as follows:

a. Give about 5 pounds per head per day through their second heat period.

b. Flush - full feed - after the second heat period until breeding in the third heat period.

After breeding, limit the feed intake to 3 to 5 pounds daily. Overfeeding during gestation can cause embryonic death and thus decrease litter size.

## 2. Breeding Boars

In moderate to high production operations where a good supply of feed is available feed 120 to 150 pound boars 6 to 9 pounds daily. Mature breeding boars should be limited to 5 to 7 lbs./day in order to keep them from becoming fat (which reduces their libido and fertility).

## 3. Brood Sows

The nutrition of brood sows is critical, for it may materially affect conception, reproduction, and lactation. Proper feeding of sows should begin with replacement gilts and continue through each stage of the breeding cycle - flushing, gestation, farrowing, and lactation.

## 4. Gestation Sows

a. Limit feed to 4 pounds/day.

b. Approximately two-thirds of the growth of the fetus is made during the last month of the gestation period. Therefore, the demands resulting from pregnancy are greatest during the latter third of the gestation period. You may wish to increase the feed to the sow by 20% during the last month of gestation. It is important for the sow not to be too fat nor too thin as she approaches farrowing. Leguminous pastures are good for gestating sows and if the pasture is of good quality the sow's grain feeds can be reduced by 1/2 during this period.

## 5. "Flushing" Sows

The practice of conditioning or having the sows gain in weight just prior to breeding is known as flushing. The purpose of flushing is to increase the number of ova shed during estrus. About 10 to 14 days prior to expected breeding, the sow should be fed a ration that will make for gains of 1 to 1 1/4 pounds per day. Generally 6 to 8 lbs. per head per day of a high-energy, 14 to 16% protein feed that is well balanced in minerals and vitamins, is adequate. This is a particularly good technique where you have a limited amount of good feed and seek large litter sizes. Under such circumstances flushing can provide good results. Immediately after breeding, the sows should be put back on limited feeding. Continuation of a high level of feeding after breeding will result in a higher embryo mortality.

## 6. Farrowing Sows

a. They should be given all the water they will drink.

b. It is good, since sows are prone to constipation during farrowing, to reduce their feed by 1/2 48 hours before farrowing. Remove all feed the day the sows farrows. The day following farrowing provide the amount of feed you were giving during gestation.

7. Lactating Sows

a. This is time of highest stress on the sow in production.

b. She needs good quality concentrates rich in high quality protein, calcium, phosphorus, and vitamins. If you have a limited amount of protein feeds available for your swine this would be a good time to use what you have because the survival of the litter depends of the sow's nutrition.

3. A good sow produces 1 gallon milk daily. The growth of the litter (as well as the survival) is directly controlled by the sow's nutrition.

4. A good rule of thumb in feeding lactating sows in one pound feed per piglet/daily (minimum of 5 pounds).

5. Give at least 1 1/2 gallons of water/per 100 pounds of body-weight/ daily to the sow, if the sow does not receive an adequate supply of milk.

6. If possible it is advisable to increase the C.P. percentage to 16% during the lactation of the sow.

Listed below are the nutrient requirements for swine at the 3 different levels of production, i.e., high investment, moderate investment, and survival production. The source of these values is the National Research Council. The 5 different catagories (ME, CP, Lysine, Calcium, and Phosphorus) listed are provided because they must balance nutritionally at the same level of production. These 5 are the limiting factors in balancing a ration.

Feed Values

| High investment | ME | CP | Lysine | Calcium | Phosphorus |
|---|---|---|---|---|---|
| | 3,190 | 14% | .61 | .55 | .45 |
| Moderate investment | 2,750 | 10% | * | * | * |
| Survival level | 2,300 | 7% | * | * | * |

* Reduced amounts are needed for lower levels of production but exact amounts are not known due to lack of research.

Included below are 2 sample rations balanced for high level production.

| Feedstuff | % of ration | ME | CP | Lysine | Calcium | Phosphorus |
|---|---|---|---|---|---|---|
| Taro | 20% | 520 | .5 | - | - | - |
| Soybean Meal | 27% | 941 | 13.1 | .73 | .07 | .17 |
| Bananas | 50% | 1600 | 1.0 | - | - | - |
| Bone meal | 3% | -- | -- | -- | .72 | .36 |
| Totals | 100% | 3061 | 14.6 | .73 | .79 | .53 |
| Corn | 85% | 2826 | 7.5 | .20 | .02 | .24 |
| Soybean Meal | 10% | 348 | 4.8 | .27 | .03 | .06 |
| Fishmeal | 4% | 100 | 2.9 | .20 | .10 | .07 |
| Vitamin & Mineral Supplement | 1% | - | - | - | * | * |
| Totals | 100% | 3274 | 15.2 | .67 | .15* | .37* |

---

* Because the calcium and phosphorus levels were too low a 1% vitamin and minerals upplement had to be added to this ration in order to balance the Ca and P levels. All 5 of these nutrients need to balance with 100% of the NRC nutrient requirement levels in order to remain at high production.

## Table 2-1
## Nutrient Requirements of Swine

### Average Composition of Some Feed Ingredients Commonly Used in Swine Diets (Excluding Amino Acids)[a]

| Line No. | | International Feed Number[b] | Dry Matter (%) | Energy (kcal/kg) | | Protein (%) | Ether Extract (%) | Crude Fiber (%) | Minerals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | DE | ME | | | | Calcium (%) | Phosphorus (%) | Potassium (%) | Chlorine (%) |
| 01 | Alfalfa meal, dehy., 17% protein | 1-00-023 | 92 | 2580 | 2270 | 17.5 | 2.5 | 24.1 | 1.44 | 0.22 | 2.40 | 0.46 |
| 02 | Barley | 4-00-549 | 89 | 3086 | 2870 | 11.6 | 1.8 | 5.1 | 0.05 | 0.36 | 0.48 | 0.15 |
| 03 | Barley, Pacific Coast | 4-07-939 | 89 | 3130 | 2940 | 9.0 | 2.0 | 6.4 | 0.05 | 0.32 | 0.53 | 0.15 |
| 04 | Beans, field (*Vicia faba*) | 5-09-262 | 89 | 3263 | 3080 | 26.0 | 1.4 | 8.2 | 0.14 | 0.54 | 1.20 | — |
| 05 | Beet pulp, dried | 4-00-669 | 91 | 2866 | 2345 | 8.0 | 0.5 | 21.0 | 0.60 | 0.10 | 0.21 | — |
| 06 | Blood meal, spray or ring dried | 5-00-381 | 86 | 2690 | 1927 | 85.0 | 1.0 | 0.6 | 0.30 | 0.25 | 0.90 | 0.27 |
| 07 | Brewers dried grains | 5-02-141 | 92 | 1940 | 1710 | 25.3 | 6.2 | 15.3 | 0.29 | 0.52 | 0.09 | 0.12 |
| 08 | Corn, dent yellow, grain | 4-02-935 | 89 | 3525 | 3325 | 8.8 | 3.8 | 2.2 | 0.02 | 0.28 | 0.30 | 0.04 |
| 09 | Corn and cob meal | 4-02-849 | 85 | 3086 | 2500 | 7.8 | 3.0 | 10.0 | 0.04 | 0.21 | 0.45 | 0.04 |
| 10 | Corn, gluten feed | 5-02-903 | 90 | 3307 | 2400 | 22.0 | 2.5 | 10.0 | 0.40 | 0.80 | 0.57 | 0.22 |
| 11 | gluten meal, 41% | 5-02-411 | 91 | 3230 | 3069 | 41.0 | 2.5 | 4.0 | 0.23 | 0.55 | 0.31 | 0.11 |
| 12 | Corn, distillers grain w/solubles, dehy. | 5-02-843 | 93 | 3568 | 3390 | 27.2 | 9.0 | 9.1 | 0.35 | 0.95 | 1.00 | 0.17 |
| 13 | Corn, distillers solubles, dehy. | 5-02-844 | 92 | 3307 | 2900 | 28.5 | 9.0 | 4.0 | 0.35 | 1.33 | 1.75 | 0.26 |
| 14 | Corn, hominy feed | 4-02-887 | 90 | 3615 | 3365 | 10.0 | 6.9 | 6.0 | 0.04 | 0.50 | 0.67 | 0.05 |
| 15 | Cottonseed meal, mechanical extracted | 5-01-609 | 93 | 2954 | 2453 | 40.9 | 3.9 | 12.6 | 0.17 | 1.05 | 1.19 | 0.04 |
| 16 | Cottonseed meal, solvent extracted | 5-01-619 | 92 | 2689 | 2555 | 41.4 | 1.5 | 11.3 | 0.15 | 0.97 | 1.22 | 0.03 |
| 17 | Feather meal | 5-03-795 | 93 | 2778 | 2270 | 86.4 | 3.3 | 1.0 | 0.20 | 0.80 | 0.31 | — |
| 18 | Fish meal, anchovy | 5-01-985 | 92 | 3086 | 2450 | 64.2 | 10.0 | 1.0 | 3.73 | 2.43 | 0.90 | 0.29 |
| 19 | herring | 5-02-000 | 93 | 3086 | 2500 | 72.3 | 10.0 | 0.7 | 2.29 | 1.70 | 1.50 | 0.90 |
| 20 | Menhaden | 5-02-009 | 92 | 2734 | 2230 | 60.5 | 9.4 | 0.7 | 5.11 | 2.88 | 0.77 | 0.60 |
| 21 | Fish solubles, condensed | 5-01-969 | 51 | 3307 | 3190 | 31.5 | 4.0 | 0.2 | 0.30 | 0.50 | 1.74 | 2.65 |
| 22 | Meat and bone meal, 50% | 5-09-322 | 93 | 2866 | 2434 | 50.4 | 8.6 | 2.8 | 10.10 | 4.96 | 1.40 | 0.74 |
| 23 | Meat meal, 55% | 5-09-323 | 92 | 2998 | 2540 | 54.4 | 7.1 | 2.5 | 8.27 | 4.10 | 1.40 | 0.91 |
| 24 | Molasses, beet | 4-00-668 | 79 | 2460 | 2320 | 6.1 | 0.0 | 0.0 | 0.13 | 0.06 | 4.83 | 1.30 |
| 25 | Molasses, cane | 4-04-696 | 74 | 2469 | 2343 | 2.9 | 0.0 | 0.0 | 0.82 | 0.08 | 2.38 | — |
| 26 | Oats | 4-03-309 | 89 | 2866 | 2668 | 11.4 | 4.2 | 10.8 | 0.06 | 0.27 | 0.37 | 0.11 |
| 27 | Oat groats (dehulled oats) | 4-03-331 | 91 | 3690 | 3400 | 16.0 | 5.5 | 3.0 | 0.07 | 0.43 | 0.34 | — |
| 28 | Peas | 5-03-600 | 90 | 3527 | 3200 | 23.8 | 1.3 | 5.5 | 0.11 | 0.42 | 1.02 | 0.06 |
| 29 | Peanut meal, expeller | 5-03-649 | 90 | 3600 | 3200 | 45.0 | 7.3 | 12.0 | 0.16 | 0.55 | 1.12 | 0.03 |
| 30 | Peanut meal, solvent | 5-03-650 | 90 | 2845 | 2920 | 47.0 | 1.2 | 13.1 | 0.20 | 0.65 | 1.15 | — |
| 31 | Rapeseed meal, solvent | 5-03-871 | 94 | 2998 | 2670 | 35.0 | 1.8 | 12.4 | 0.66 | 1.09 | 0.80 | — |
| 32 | Rice bran, solvent | 4-03-930 | 91 | 3080 | 2200 | 12.9 | 0.6 | 11.4 | 0.07 | 1.50 | 1.35 | 0.07 |
| 33 | Rice, broken | 4-03-932 | 89 | 2513 | 2360 | 8.7 | 1.7 | 9.8 | 0.08 | — | — | 0.08 |
| 34 | Rice, polishings | 4-03-943 | 90 | 3792 | 3000 | 12.2 | 11.0 | 4.1 | 0.05 | 1.31 | 1.06 | 0.11 |
| 35 | Rye, grain | 4-04-047 | 89 | 3307 | 2712 | 12.6 | 1.8 | 2.8 | 0.08 | 0.30 | 0.46 | — |
| 36 | Safflower meal, solvent | 5-04-110 | 91 | 2960 | 2435 | 28.5 | 0.5 | 30.6 | 0.40 | 1.10 | 0.80 | — |
| 37 | Sesame meal, expeller | 5-04-220 | 93 | 3130 | 2560 | 42.0 | 7.0 | 6.5 | 1.99 | 1.37 | 1.20 | 0.06 |
| 38 | Skim milk, dried | 5-01-175 | 92 | 3792 | 3360 | 33.5 | 0.9 | 0.0 | 1.28 | 1.02 | 1.59 | 0.50 |
| 39 | Sorghum, grain (Milo) | 4-04-444 | 89 | 3439 | 3229 | 8.9 | 2.8 | 2.3 | 0.03 | 0.28 | 0.32 | 0.09 |
| 40 | Soybeans, full-fat cooked | 5-04-597 | 90 | 4056 | 3540 | 37.0 | 18.0 | 5.5 | 0.25 | 0.58 | 1.61 | 0.03 |
| 41 | Soybean meal, dehulled, solvent | 5-04-612 | 90 | 3860 | 3485 | 48.5 | 1.0 | 3.9 | 0.27 | 0.62 | 2.02 | 0.05 |
| 42 | Soybean meal, expeller | 5-04-600 | 90 | 3483 | 2990 | 42.6 | 4.0 | 6.2 | 0.27 | 0.61 | 1.83 | 0.07 |
| 43 | Soybean meal, solvent | 5-04-604 | 89 | 3350 | 3090 | 44.0 | 0.8 | 7.3 | 0.29 | 0.65 | 2.00 | 0.05 |
| 44 | Sunflower meal, dehulled, solvent | 5-04-739 | 93 | 2998 | 2605 | 42.0 | 2.9 | 12.2 | 0.37 | 1.00 | 1.00 | 0.10 |
| 45 | Wheat bran | 4-05-190 | 90 | 2513 | 2320 | 15.7 | 4.0 | 11.0 | 0.14 | 1.15 | 1.19 | 0.06 |
| 46 | Wheat shorts | 4-05-201 | 89 | 3175 | 2910 | 16.8 | 4.2 | 8.2 | 0.11 | 0.76 | 0.88 | 0.07 |
| 47 | Wheat middlings | 4-05-205 | 88 | 3050 | 2940 | 16.0 | 3.0 | 7.0 | 0.12 | 0.90 | 0.60 | 0.03 |
| 48 | Wheat, hard, red winter | 4-05-268 | 87 | 3483 | 3220 | 14.1 | 1.9 | 2.4 | 0.05 | 0.37 | 0.45 | 0.05 |
| 49 | Wheat, soft, red winter | 4-05-294 | 86 | 3659 | 3416 | 10.2 | 1.8 | 2.4 | 0.05 | 0.31 | 0.40 | 0.08 |
| 50 | Whey, dried | 4-01-182 | 93 | 3439 | 3190 | 13.6 | 0.8 | 1.3 | 0.97 | 0.76 | 1.05 | 1.50 |
| 51 | Whey, low lactose | 4-01-186 | 91 | 3307 | 2750 | 15.5 | 1.0 | 0.3 | 1.95 | 0.98 | 3.00 | 2.10 |
| 52 | Yeast, brewers dried | 7-05-527 | 93 | 3135 | 2707 | 44.4 | 1.0 | 2.7 | 0.12 | 1.40 | 1.70 | 0.12 |

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[a] As fed basis.

[b] The first digit is the feed class, coded as follows: (1) dry forages and roughages; (2) pasture, range plants and forages fed green; (3) silages; (4) energy feeds, and (5) protein supplements.

From: Nutrient Requirements of Swine, Eighth Revised Edition, 1979, The National Research Council, National Academy of Sciences Press.

Table 2-1
Nutrient Requirements of Swine
Page 2

| | | | | | | | | | Vitamins | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Line No. | Magnesium (%) | Sodium (%) | Sulfur (%) | Copper (mg/kg) | Iron (mg/kg) | Manganese (mg/kg) | Selenium (mg/kg) | Zinc (mg/kg) | Biotin (mg/kg) | Choline (mg/kg) | Folacin (mg/kg) | Niacin (mg/kg) | Pantothenic Acid (mg/kg) | Pyridoxine (mg/kg) | Riboflavin (mg/kg) | Thiamin (mg/kg) | Vitamin $B_{12}$ (mg/kg) | Vitamin E (IU/kg) |
| 01 | 0.26 | 0.08 | 0.21 | 8.2 | 310 | 28.0 | 0.60 | 17 | 0.30 | 1097 | 6.3 | 38 | 28.4 | 6.5 | 15.7 | 3.4 | 0.004 | 125 |
| 02 | 0.14 | 0.04 | 0.15 | 7.5 | 50 | 8.0 | 0.10 | 17 | 0.08 | 990 | 0.5 | 63 | 9.2 | 3.0 | 1.2 | 4.0 | — | 36 |
| 03 | 0.12 | 0.02 | — | 7.7 | 60 | 16.3 | 0.10 | 15 | 0.15 | 1034 | 0.5 | 48 | 7.0 | 2.9 | 1.6 | 5.5 | — | 36 |
| 04 | 0.13 | 0.80 | — | 4.1 | 70 | 8.4 | — | 42 | 0.09 | 1670 | — | 22 | 3.0 | — | 1.6 | 5.5 | — | 1 |
| 05 | 0.27 | 0.32 | 0.20 | 12.5 | 300 | 35.0 | — | 0.7 | — | 800 | — | 20 | 0.8 | — | 1.1 | 0.2 | — | — |
| 06 | 0.22 | 0.33 | 0.32 | 8.1 | 3000 | 6.4 | — | 306 | 0.30 | 749 | 0.3 | 22 | 1.1 | 4.4 | 1.3 | 0.5 | 0.440 | — |
| 07 | 0.16 | 0.15 | 0.31 | 21.1 | 250 | 37.8 | 0.70 | 98 | 0.96 | 1723 | 7.1 | 29 | 8.0 | 0.7 | 1.4 | 0.5 | — | 25 |
| 08 | 0.12 | 0.02 | 0.08 | 3.4 | 35 | 5.0 | 0.04 | 10 | 0.11 | 530 | 0.2 | 34 | 7.5 | 7.0 | 1.0 | 3.5 | — | 22 |
| 09 | 0.13 | 0.01 | 0.18 | 6.7 | 70 | 7.7 | 0.07 | 9 | 0.05 | 393 | 0.3 | 17 | 4.0 | 5.0 | 0.9 | — | — | 19 |
| 10 | 0.29 | 0.95 | 0.22 | 47.9 | 460 | 23.8 | 0.10 | 48 | 0.33 | 1518 | 0.3 | 66 | 17.0 | 15.0 | 2.4 | 2.0 | — | 15 |
| 11 | 0.05 | 0.07 | 0.40 | 28.3 | 400 | 8.9 | 1.00 | 20 | 0.18 | 330 | 0.2 | 50 | 10.0 | 7.9 | 1.7 | 0.2 | — | 20 |
| 12 | 0.35 | 0.90 | 0.30 | 44.7 | 280 | 30.0 | 0.39 | 80 | 0.30 | 3400 | 0.9 | 80 | 11.0 | 2.2 | 8.6 | 3.5 | — | 40 |
| 13 | 0.64 | 0.26 | 0.37 | 82.7 | 560 | 73.7 | 0.33 | 85 | 1.40 | 4842 | 1.1 | 116 | 21.0 | 10.0 | 11.6 | 6.9 | — | 55 |
| 14 | 0.24 | 0.10 | 0.03 | 13.3 | 70 | 14.5 | — | 3 | 0.13 | 1500 | 0.3 | 46 | 8.0 | 11.0 | 2.2 | 7.9 | — | — |
| 15 | 0.42 | 0.04 | 0.40 | 18.6 | 160 | 22.9 | 0.90 | 57 | 0.60 | 2753 | 2.7 | 38 | 7.7 | 5.3 | 4.2 | 9.7 | — | 15 |
| 16 | 0.40 | 0.04 | — | 17.8 | 110 | 20.2 | — | — | 0.55 | 2933 | 2.7 | 40 | 9.9 | 3.0 | 4.0 | 7.7 | — | 15 |
| 17 | 0.20 | 0.71 | — | — | — | 21.0 | — | — | 0.04 | 891 | 0.2 | 27 | 10.0 | — | 2.1 | 0.1 | 0.600 | — |
| 18 | 0.24 | 1.10 | 0.54 | 9.3 | 220 | 9.5 | 1.36 | 103 | 0.23 | 5100 | 0.2 | 135 | 20.0 | 4.0 | 7.1 | 0.1 | 0.352 | 6 |
| 19 | 0.15 | 0.61 | 0.69 | 4.5 | 80 | 4.7 | 1.93 | 132 | 0.20 | 5306 | 0.5 | 142 | 22.0 | 4.0 | 9.9 | 0.1 | 0.588 | 17 |
| 20 | 0.16 | 0.41 | 0.45 | 10.8 | 440 | 33.0 | 2.10 | 147 | 0.15 | 3056 | 1.0 | 55 | 9.0 | 4.0 | 4.9 | 0.2 | 0.150 | 7 |
| 21 | 0.02 | 3.10 | 0.12 | 44.9 | 30 | 14.4 | 2.00 | 38 | 0.18 | 4028 | — | 169 | 35.0 | 12.2 | 14.6 | 5.5 | 0.347 | — |
| 22 | 1.12 | 0.72 | 0.26 | 1.5 | 490 | 14.2 | 0.25 | 93 | 0.14 | 1996 | 0.6 | 46 | 4.1 | 12.8 | 4.4 | 0.2 | 0.070 | 0.8 |
| 23 | 1.13 | 0.73 | 0.26 | 1.5 | 440 | 12.3 | 0.25 | 103 | 0.14 | 2077 | 0.6 | 57 | 5.0 | 3.0 | 5.5 | 0.2 | — | 0.8 |
| 24 | 0.23 | — | 0.48 | 17.7 | 70 | 4.7 | — | 14 | 0.70 | 880 | — | 48 | 4.0 | — | 2.1 | — | — | 4.4 |
| 25 | 0.35 | 0.90 | 0.35 | 59.6 | 200 | 42.2 | — | — | 0.70 | 660 | — | 45 | 39.0 | — | 2.3 | 0.9 | — | 4.4 |
| 26 | 0.16 | 0.06 | 0.21 | 5.9 | 70 | 43.2 | 0.30 | 1 | 0.30 | 1100 | 0.4 | 15 | 29.2 | 1.0 | 1.1 | 6.0 | — | 20.0 |
| 27 | 0.09 | — | 0.20 | 6.4 | 90 | 28.6 | — | — | 0.20 | 1232 | 0.3 | 18 | 11.0 | — | 1.3 | 6.8 | — | 15.0 |
| 28 | — | 0.04 | — | — | 50 | — | — | 30 | 0.18 | 642 | 0.4 | 17 | 4.6 | 1.0 | 0.8 | 1.8 | — | — |
| 29 | 0.32 | — | 0.28 | — | — | 24.8 | — | — | 0.39 | 1640 | — | 165 | 46.8 | — | 5.1 | 7.1 | — | 2.9 |
| 30 | 0.40 | 0.10 | — | — | — | 29.9 | — | — | 0.39 | 1980 | — | 165 | 50.6 | — | 11.0 | 6.6 | — | 3.0 |
| 31 | 0.51 | 0.50 | — | 7.0 | 180 | 43.0 | 0.98 | 66 | — | 6464 | — | 153 | 9.0 | 7.0 | 3.7 | 1.7 | — | 19.1 |
| 32 | 0.95 | 0.07 | 0.18 | 13.0 | 190 | 138.0 | — | 30 | 4.20 | 1135 | — | 293 | 23.0 | 14.0 | 2.5 | 22.5 | — | 59.8 |
| 33 | 0.11 | 0.07 | 0.06 | — | — | 18.0 | — | 17 | 0.08 | 800 | 0.2 | 46 | 8.0 | — | 0.7 | — | — | 14.5 |
| 34 | 0.65 | 0.10 | 0.17 | — | 160 | — | — | — | 0.61 | 1237 | — | 520 | 47.0 | — | 1.8 | 19.8 | — | 90.0 |
| 35 | 0.12 | 0.02 | 0.15 | 7.8 | 100 | 66.9 | — | 31 | 0.60 | — | 0.6 | 16 | 9.2 | — | 1.5 | 4.4 | — | 15.0 |
| 36 | 0.37 | 0.06 | — | 10.8 | 560 | 19.8 | — | 44 | 1.56 | 2247 | 0.5 | 60 | 43.8 | — | 11.3 | 2.8 | — | 0.9 |
| 37 | 0.86 | 0.04 | 0.43 | — | — | 47.9 | — | 100 | 0.34 | 1690 | — | 30 | 6.0 | 12.5 | 3.6 | 2.8 | — | — |
| 38 | 0.11 | 0.44 | 0.31 | 11.5 | 50 | 2.0 | 0.12 | 40 | 0.33 | 1250 | 0.6 | 12 | 33.0 | 3.9 | 22.0 | 3.5 | 0.010 | 9.1 |
| 39 | 0.20 | 0.01 | 0.09 | 14.1 | 40 | 12.9 | — | 14 | 0.09 | 678 | 0.2 | 41 | 12.0 | 3.2 | 1.1 | 4.0 | — | 12.0 |
| 40 | 0.21 | 0.28 | 0.22 | 15.8 | 80 | 29.8 | 0.11 | 16 | 0.27 | 2420 | 3.5 | 22 | 15.6 | 10.8 | 2.6 | 6.6 | — | 0.9 |
| 41 | 0.27 | 0.34 | 0.43 | 36.3 | 120 | 27.5 | 0.10 | 45 | 0.32 | 2850 | 0.7 | 22 | 15.0 | 5.0 | 2.9 | 1.7 | — | 3.3 |
| 42 | 0.26 | 0.27 | 0.33 | 18.0 | 140 | 30.7 | 0.10 | 60 | 0.33 | 2703 | 0.5 | 37 | 14.0 | — | 3.7 | 1.7 | — | 6.1 |
| 43 | 0.27 | 0.34 | 0.43 | 36.3 | 120 | 29.3 | 0.10 | 27 | 0.32 | 2794 | 0.5 | 60 | 13.3 | 8.0 | 2.9 | 1.7 | — | 2.1 |
| 44 | 0.75 | 2.00 | — | 3.5 | 30 | 22.9 | — | — | 1.45 | 2894 | — | 220 | 10.0 | 16.0 | 3.1 | — | — | 11.0 |
| 45 | 0.52 | 0.05 | 0.22 | 10.2 | 170 | 100.0 | 0.50 | 95 | 0.10 | 980 | 1.8 | 321 | 31.0 | 7.0 | 3.1 | 8.0 | — | 10.8 |
| 46 | 0.26 | 0.07 | 0.23 | 12.1 | 100 | 115.0 | 0.50 | 106 | 0.10 | 930 | 1.4 | 100 | 17.6 | 11.0 | 2.0 | 19.9 | — | 29.9 |
| 47 | 0.29 | 0.60 | 0.16 | 4.4 | 40 | 43.0 | 0.80 | 64 | 0.10 | 1100 | 0.6 | 53 | 13.0 | 9.0 | 2.2 | 18.9 | — | — |
| 48 | 0.17 | 0.04 | 0.12 | 10.6 | 50 | 62.2 | 0.06 | 14 | 0.04 | 1090 | 0.4 | 56 | 13.5 | 3.4 | 1.4 | 4.5 | — | 12.6 |
| 49 | 0.10 | 0.04 | 0.12 | 9.7 | 40 | 51.3 | 0.06 | 14 | 0.04 | 788 | 0.4 | 48 | 11.0 | 4.0 | 1.2 | 4.3 | — | 13.2 |
| 50 | 0.13 | 2.00 | 1.04 | 40.0 | 130 | 6.1 | 0.06 | — | 0.34 | 1980 | 0.8 | 10 | 44.0 | 4.0 | 27.1 | 4.1 | 0.015 | 0.2 |
| 51 | 0.25 | 1.50 | — | — | — | 14.0 | 0.06 | — | 0.64 | 4392 | 1.4 | 19 | 69.0 | 4.0 | 29.9 | 5.7 | 0.015 | — |
| 52 | 0.23 | 0.07 | 0.38 | 32.8 | 120 | 5.2 | 1.00 | 39 | 1.05 | 3984 | 9.9 | 448 | 109.0 | 42.8 | 37.0 | 91.8 | — | — |

From: Nutrient Requirements of Swine, Eighth Revised Edition, 1979, The National Research Council, National Academy of Sciences Press.

Table 2-2

## Average Amino Acid Composition of Some Commonly Used Feedstuff[a]

| | International Feed Number[b] | Protein (%) | Arginine (%) | Histidine (%) | Isoleucine (%) | Leucine (%) | Lysine (%) | Methionine (%) | Cystine (%) | Phenylalanine (%) | Tyrosine (%) | Threonine (%) | Tryptophan (%) | Valine (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alfalfa meal, dehy., 17% protein | 1-00-023 | 17.5 | 0.8 | 0.3 | 0.8 | 1.3 | 0.73 | 0.2 | 0.2 | 0.8 | 0.6 | 0.70 | 0.28 | 0.8 |
| Barley | 4-00-549 | 11.6 | 0.6 | 0.3 | 0.5 | 0.8 | 0.40 | 0.2 | 0.3 | 0.6 | 0.3 | 0.42 | 0.14 | 0.6 |
| Barley, Pacific Coast | 4-07-939 | 9.0 | 0.5 | 0.2 | 0.4 | 0.6 | 0.29 | 0.1 | 0.2 | 0.5 | 0.3 | 0.30 | 0.12 | 0.5 |
| Beans, field (*Vicia faba*) | 5-09-262 | 27.4 | 2.5 | 0.7 | 1.1 | 1.9 | 1.72 | 0.2 | 0.2 | 1.2 | 0.7 | 3.96 | 0.24 | 1.2 |
| Beet pulp, dried | 4-00-669 | 8.0 | 0.3 | 0.2 | 0.3 | 0.6 | 0.60 | 0.01 | 0.01 | 0.3 | 0.4 | 0.40 | 0.10 | 0.4 |
| Blood meal, spray or ring dried | 5-00-381 | 85.0 | 4.1 | 5.5 | 1.0 | 12.7 | 8.10 | 1.5 | 1.5 | 7.3 | 3.0 | 4.90 | 1.10 | 9.1 |
| Brewers dried grains | 5-02-141 | 25.3 | 0.8 | 0.6 | 1.4 | 2.5 | 0.90 | 0.6 | 0.4 | 1.5 | 1.2 | 0.98 | 0.34 | 1.7 |
| Corn, dent yellow, grain | 4-02-935 | 8.8 | 0.5 | 0.2 | 0.4 | 1.1 | 0.24 | 0.2 | 0.2 | 0.5 | 0.5 | 0.39 | 0.05 | 0.4 |
| Corn and cob meal | 4-02-849 | 7.8 | 0.4 | 0.2 | 0.4 | 1.0 | 0.18 | 0.1 | 0.1 | 0.4 | — | 0.35 | 0.07 | 0.4 |
| Corn, gluten feed | 5-02-903 | 22.0 | 1.0 | 0.7 | 0.7 | 1.9 | 0.63 | 0.5 | 0.5 | 0.8 | 0.6 | 0.89 | 0.10 | 1.0 |
| gluten meal, 41% | 5-02-411 | 40.6 | 1.4 | 1.0 | 2.2 | 7.2 | 0.78 | 1.0 | 0.7 | 2.9 | 1.0 | 1.40 | 0.21 | 2.2 |
| Corn, distillers grain w/solubles, dehy. | 5-02-843 | 27.2 | 1.0 | 0.7 | 1.0 | 2.6 | 0.60 | 0.6 | 0.3 | 1.2 | 0.7 | 0.92 | 0.19 | 1.3 |
| Corn, distillers solubles, dehy. | 5-02-844 | 28.5 | 1.1 | 0.7 | 1.3 | 2.1 | 0.90 | 0.5 | 0.4 | 1.3 | 1.0 | 1.00 | 0.30 | 1.4 |
| Corn, hominy feed | 4-02-887 | 10.0 | 0.5 | 0.2 | 0.4 | 0.8 | 0.40 | 0.1 | 0.1 | 0.4 | 0.5 | 0.40 | 0.10 | 0.5 |
| Cottonseed meal, mechanical extracted | 5-01-609 | 40.9 | 4.3 | 1.1 | 1.6 | 2.5 | 1.51 | 0.6 | 0.6 | 2.2 | 1.1 | 1.38 | 0.55 | 2.0 |
| Cottonseed meal, solvent extracted | 5-01-619 | 41.4 | 4.6 | 1.1 | 1.3 | 2.4 | 1.71 | 0.5 | 0.6 | 2.2 | 1.0 | 1.32 | 0.47 | 1.9 |
| Feather meal | 5-03-795 | 86.4 | 3.9 | 0.3 | 2.7 | 6.7 | 1.10 | 0.4 | 3.0 | 2.7 | 6.3 | 2.80 | 0.50 | 4.6 |
| Fish meal, anchovy | 5-01-985 | 64.2 | 3.7 | 1.5 | 3.0 | 5.0 | 5.10 | 1.9 | 0.6 | 2.7 | 2.2 | 2.68 | 0.74 | 3.4 |
| herring | 5-02-000 | 72.3 | 4.8 | 1.7 | 3.2 | 5.3 | 5.70 | 2.1 | 0.7 | 2.8 | 2.3 | 3.00 | 0.81 | 4.4 |
| Menhaden | 5-02-009 | 60.5 | 3.8 | 1.5 | 2.9 | 5.0 | 4.83 | 1.8 | 0.6 | 2.5 | 2.0 | 2.50 | 0.68 | 3.2 |
| Fish solubles, 50% solids | 5-01-969 | 31.5 | 1.6 | 1.6 | 0.7 | 1.9 | 1.73 | 0.5 | 0.3 | 0.9 | 0.4 | 0.86 | 0.31 | 1.2 |
| Meat and bone meal, 50% | 5-09-322 | 50.4 | 3.6 | 1.2 | 1.4 | 3.2 | 2.60 | 0.7 | 0.3 | 1.5 | 0.8 | 1.50 | 0.28 | 2.3 |
| Meat meal, 55% | 5-09-323 | 54.4 | 3.7 | 1.3 | 1.6 | 3.3 | 3.00 | 0.8 | 0.7 | 1.7 | 1.8 | 1.74 | 0.36 | 2.6 |
| Oats | 4-03-309 | 11.4 | 0.8 | 0.2 | 0.5 | 0.9 | 0.40 | 0.2 | 0.2 | 0.6 | 0.5 | 0.43 | 0.16 | 0.7 |
| Oat groats (dehulled oats) | 4-03-331 | 16.0 | 0.7 | 0.3 | 0.5 | 1.0 | 0.60 | 0.2 | 0.3 | 0.7 | 0.9 | 0.50 | 0.18 | 0.7 |
| Peas | 5-03-600 | 23.8 | 1.4 | 0.7 | 1.1 | 1.8 | 1.60 | 0.3 | 0.2 | 1.3 | — | 0.94 | 0.24 | 1.3 |
| Peanut meal, expeller | 5-03-649 | 45.0 | 4.7 | 1.1 | 1.8 | 3.6 | 1.55 | 0.4 | 0.7 | 2.6 | — | 1.40 | 0.46 | 2.6 |
| Peanut meal, solvent | 5-03-650 | 47.0 | 4.9 | 1.2 | 2.1 | 3.7 | 1.76 | 0.4 | 0.8 | 2.8 | 2.0 | 1.45 | 0.48 | 2.8 |
| Rapeseed meal, solvent | 5-03-871 | 35.0 | 1.9 | 1.0 | 1.3 | 2.3 | 2.10 | 0.7 | 0.4 | 1.4 | 0.8 | 1.53 | 0.45 | 1.8 |
| Rice bran, solvent | 4-03-930 | 12.9 | 0.9 | 0.3 | 0.4 | 0.9 | 0.59 | 0.2 | 0.1 | 0.6 | 0.7 | 0.48 | 0.15 | 0.6 |
| Rice, broken | 4-03-932 | 8.7 | 0.6 | 0.2 | 0.3 | 0.5 | 0.24 | 0.1 | 0.1 | 0.3 | — | 0.27 | 0.10 | 0.5 |
| Rice, polishings | 4-03-943 | 12.2 | 0.8 | 0.2 | 0.4 | 0.8 | 0.57 | 0.2 | 0.1 | 0.5 | 0.6 | 0.40 | 0.13 | 0.8 |
| Rye, grain | 4-04-047 | 12.6 | 0.5 | 0.3 | 0.5 | 0.7 | 0.49 | 0.2 | 0.2 | 0.6 | 0.3 | 0.86 | 0.12 | 0.6 |
| Safflower meal, solvent | 5-04-110 | 28.5 | 3.7 | 1.0 | 1.7 | 2.5 | 1.30 | 0.7 | 0.7 | 1.9 | — | 1.35 | 0.60 | 2.3 |
| Sesame meal, expeller | 5-04-220 | 42.0 | 4.2 | 1.1 | 2.1 | 3.3 | 1.30 | 1.2 | 0.6 | 2.2 | 2.0 | 1.65 | 0.80 | 2.4 |
| Skim milk, dried | 5-01-175 | 33.5 | 1.1 | 0.8 | 2.2 | 3.2 | 2.40 | 0.9 | 0.4 | 1.6 | 1.1 | 1.60 | 0.44 | 2.3 |
| Sorghum, grain (Milo) | 4-04-383 | 8.9 | 0.4 | 0.3 | 0.5 | 1.4 | 0.22 | 0.1 | 0.2 | 0.4 | 0.4 | 0.27 | 0.10 | 0.5 |
| Soybeans, full-fat cooked | 5-04-597 | 37.0 | 2.8 | 0.9 | 2.0 | 2.8 | 2.40 | 0.5 | 0.6 | 1.8 | 1.2 | 1.50 | 0.55 | 1.8 |
| Soybean meal, dehulled, solvent | 5-04-612 | 48.5 | 3.7 | 1.3 | 2.6 | 3.8 | 3.18 | 0.7 | 0.7 | 2.1 | 2.0 | 1.91 | 0.67 | 2.7 |
| Soybean meal, solvent | 5-04-604 | 44.0 | 3.3 | 1.2 | 2.4 | 3.5 | 2.93 | 0.7 | 0.7 | 2.3 | 1.3 | 1.81 | 0.62 | 2.3 |
| Sunflower meal, dehulled, solvent | 5-04-739 | 42.0 | 3.3 | 1.4 | 2.8 | 3.9 | 1.70 | 0.7 | 0.7 | 2.9 | 1.2 | 2.13 | 0.71 | 3.2 |
| Wheat bran | 4-05-190 | 15.7 | 1.0 | 0.3 | 0.6 | 0.9 | 0.59 | 0.2 | 0.3 | 0.5 | 0.4 | 0.42 | 0.30 | 0.7 |
| Wheat, hard, red winter | 4-05-268 | 14.1 | 0.6 | 0.2 | 0.6 | 0.9 | 0.40 | 0.2 | 0.3 | 0.7 | 0.6 | 0.37 | 0.18 | 0.6 |
| Wheat middlings | 4-05-205 | 16.0 | 1.8 | 0.4 | 0.6 | 1.1 | 0.69 | 0.2 | 0.3 | 0.6 | 0.5 | 0.49 | 0.20 | 0.7 |
| Wheat shorts | 4-05-201 | 16.8 | 1.2 | 0.5 | 0.6 | 1.1 | 0.81 | 0.2 | 0.3 | 0.7 | 0.5 | 0.61 | 0.19 | 0.8 |
| Wheat, soft, red winter | 4-05-294 | 10.2 | 0.4 | 0.2 | 0.4 | 0.6 | 0.31 | 0.2 | 0.2 | 0.5 | 0.4 | 0.32 | 0.12 | 0.4 |
| Whey, dried | 4-01-182 | 12.0 | 0.3 | 0.2 | 0.8 | 1.2 | 0.97 | 0.2 | 0.3 | 0.3 | 0.3 | 0.89 | 0.19 | 0.7 |
| Whey, low lactose | 4-01-186 | 15.5 | 0.7 | 0.1 | 0.3 | 0.2 | 1.47 | 0.6 | 0.6 | 0.1 | 0.2 | 0.50 | 0.18 | 0.3 |
| Yeast, brewers dried | 4-05-527 | 44.4 | 2.2 | 1.1 | 2.1 | 3.2 | 3.23 | 0.7 | 0.5 | 1.8 | 1.5 | 2.06 | 0.49 | 2.3 |

[a] As fed basis.

[b] The first digit is the feed class, coded as follows: (1) dry forages and roughages; (2) pasture, range plants and forages fed green; (3) silages; (4) energy feeds and (5) protein supplements.

From: Nutrient Requirements of Swine, Eighth Revised Edition, 1979, The National Research Council, National Academy of Sciences Press.

Table 2-3
Common Mineral Sources for Swine

| Mineral | Source | Chemical Formula | Mineral Content* | | | |
|---|---|---|---|---|---|---|
| Calcium | Calcium carbonate | | 40%Ca | 0.02%Na | | |
| | Limestone | | 38%Ca | 0.05%Na | 0.01%F | |
| Calcium and phosphorus | Bone meal | | 24%Ca | 12.6 %P | 0.37%Na | 0.05%F |
| | Phosphate, curacao | | 36%Ca | 14 %P | 0.3 %Na | 0.54%F |
| | defluorinated | | 30-34%Ca | 18 %P | 5.7 %Na | 0.16%F |
| | dicalcium | | 18–24%Ca | 18.5 %P | 0.6 %Na | 0.14%F |
| | mono and dicalcium | | 16–19%Ca | 21 %P | 0.6 %Na | 0.20%F |
| | soft rock | | 17%Ca | 9 %P | 0.1 %Na | 1.2 %F |
| | sodium tripoly | | 0 | 25 %P | 31.2 %Na | 0.03%F |
| Sodium and chlorine | Sodium chloride | | 39.3 %Na | 60.7 %Cl | | |
| Iron | Ferrous sulfate | $FeSO_4\ H_2O$ | 32.9 %Fe | | | |
| | Ferrous sulfate | $FeSO_4\ 7H_2O$ | 20.1 %Fe | | | |
| | Ferric ammonium citrate | | 16.5–18.5 %Fe | | | |
| | Ferrous fumarate | $FeC_4H_2O_4$ | 32.9 %Fe | | | |
| | Ferric chloride | $FeCl_3\ 6H_2O$ | 20.7 %Fe | | | |
| | Ferrous carbonate | $FeCO_3$ | 48.2 %Fe | | | |
| | Ferric oxide | $Fe_2O_3$ | 69.9 %Fe | | | |
| | Ferrous oxide | $FeO$ | 77.8 %Fe | | | |
| Copper | Cupric carbonate | $CuCO_3\ Cu(OH)_2$ | 57.5 %Cu | | | |
| | Cupric chloride | $CuCl_2\ 2H_2O$ | 37.3 %Cu | | | |
| | Cupric hydroxide | $Cu(OH)_2$ | 65.1 %Cu | | | |
| | Cupric oxide | $CuO$ | 79.9 %Cu | | | |
| | Cupric sulfate | $CuSO_4\ 5H_2O$ | 25.4 %Cu | | | |
| Manganese | Manganese carbonate | $MnCO_3$ | 47.8 %Mn | | | |
| | Manganous chloride | $MnCl_2\ 4H_2O$ | 27.8 %Mn | | | |
| | Manganous oxide | $MnO$ | 77.4 %Mn | | | |
| | Manganese sulfate | $MnSO_4\ 5H_2O$ | 22.7 %Mn | | | |
| | Manganous sulfate | $MnSO_4\ H_2O$ | 32.5 %Mn | | | |
| Zinc | Zinc carbonate | $5ZnO\ 2CO_2\ 4H_2O$ | 56.0 %Zn | | | |
| | Zinc chloride | $ZnCl_2$ | 48.0 %Zn | | | |
| | Zinc oxide | $ZnO$ | 80.3 %Zn | | | |
| | Zinc sulfate | $ZnSO_4\ 7H_2O$ | 22.7 %Zn | | | |
| | Zinc sulfate | $ZnSO_4\ H_2O$ | 36.4 %Zn | | | |
| Iodine | Calcium iodate | $Ca(IO_3)_2$ | 65.1 %I | | | |
| | Potassium iodide | $KI$ | 76.4 %I | | | |
| | Cuprous iodide | $CuI$ | 66.6 %I | | | |
| | Penta calcium orthoperiodate | $Ca_5(IO_6)_2$ | 39.3 %I | | | |
| Selenium | Sodium selenite | $Na_2SeO_3$ | 45.6 %Se | 26.6 %Na | | |
| | Sodium selenate | $Na_2SeO_4$ | 41.8 %Se | 24.3 %Na | | |

* Actual mineral levels in technical grade sources may vary.

From: Nutrient Requirements of Swine, Eighth Revised Edition, 1979, The National Research Council, National Academy of Sciences Press.

Table 2-4
Swine Mineral Chart

| Minerals Which May Be Deficient Under Normal Conditions | Conditions Usually Prevailing Where Deficiencies Are Reported | Function of Mineral | Some Deficiency Symptoms |
|---|---|---|---|
| **Major or macro minerals:**<br>**Salt** (sodium and chlorine—NaCl) | Salt deficiencies may exist when the protein supplement is all or chiefly of plant origin, although herbivorous animals require more salt than swine. | Salt contains both sodium and chlorine, vital elements found in the fluids and soft tissues of the body.<br>Improves appetite, promotes growth, helps regulate body pH, and is essential for hydrochloric acid formation in the stomach. | Poor and depraved appetite, unthrifty condition, and failure to grow. |
| **Calcium** (Ca) | When the protein supplements are chiefly of plant origin and little forage is used.<br>When swine are raised in confinement without vitamin D added to the ration.<br>When feed intake is restricted during gestation.<br>When there is poor calcium-phosphorus ratio.<br>Retention of calcium is affected by source of dietary protein (or phytic acid content) and the level of magnesium. | Bone and teeth formation; nerve function; muscle contraction; blood coagulation; cell permeability.<br>Essential for milk production. | Loss of appetite and poor growth, lack of thrift, lameness and stiffness, weakened bone structure, and impaired reproduction. Severe cases may show reduced serum calcium and tetany. Rickets may develop in young pigs, or osteomalacia in older animals. |
| **Phosphorus** (P) | Rations containing only plant ingredients; late gestation; lactation; high-calcium rations; swine in confinement without vitamin D added to the ration; poor calcium to phosphorus ratio.<br>Retention of phosphorus is affected by source of dietary protein (or phytic acid content) and the level of magnesium. | Bone and teeth formation; a component of phospholipids which are important in lipid transport and metabolism and cell-membrane structure.<br>In energy metabolism.<br>A component of RNA and DNA, the vital cellular constituents required for protein synthesis.<br>A constituent of several enzyme systems. | Loss of appetite and poor growth, lameness and stiffness, weakened bone structure, reduced inorganic blood phosphorus, depraved appetite, breeding difficulties, and rickets in young pigs, or osteomalacia in older animals. |
| **Magnesium** (Mn) | Essential in many enzyme systems. | Essential for normal skeletal development, as a constituent of bone, enzyme activator, primarily in glycolytic system. | Hyperirritability, muscular twitching, reluctance to stand, stepping syndrome, weak pasterns, loss of equilibrium, and tetany, followed by death. |
| **Potassium** (K) | | Major cation of intracellular fluid where it is involved is osmotic pressure and acid-base balance.<br>Muscle activity.<br>Required in enzyme reaction involving phosphorylation of creatine.<br>Influences carbohydrate metabolism. | Loss of appetite, slow growth, poor hair and skin condition, decreased feed efficiency, and cardiac impairment. |
| **Trace or micro minerals:**<br>**Cobalt** (Co) | If vitamin $B_{12}$ is limited. | An essential component of vitamin $B_{12}$. | |

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Table 2-4
Swine Mineral Chart
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| Mineral Requirements[1] | | | | |
|---|---|---|---|---|
| **Minerals/ Animal/Day** | **Mineral Content of Ration** | **Recommended Allowances[1]** | **Practical Sources of the Mineral** | **Comments** |
| Variable according to class, age, and weight of swine (see Tables 23-1 and 23-2).<br>Salt (NaCl) | Variable according to class, age, and weight of swine (see Tables 23-3 and 23-4).<br>*Pigs weighing 28.7–77.2 lb (*13–35 kg*) require 0.08–0.10% sodium and 0.12–0.13% chlorine in the as-fed ration. | *0.25–0.5% in the as-fed ration, or give hogs free access to salt alone or in a mineral mixture. | Salt in loose form.<br>A good deal of salt is provided by tankage and fish meal. | In iodine-deficient areas, stabilized iodized salt should be used.<br>When pigs are salt starved, precaution should be taken to prevent overeating of it.<br>The salt-poisoning syndrome associated with feeding brine or salted fish meal to swine can be produced by adding 6–8% salt (on a dry matter basis) to the regular diet of pigs and giving a limited amount of water. |
| Variable according to class, age, and weight of swine (see Tables 23-1 and 23-2).<br>Calcium (Ca) | Variable according to class, age, and weight of swine (see Tables 23-3 and 23-4). | Self-feed suitable mineral, or add Ca to the as-fed ration as required to bring level of total ration slightly above requirements.<br>*0.75% Ca in the as-fed ration is adequate for both male and female breeding swine. | Ground limestone, or oystershell flour.<br>Where both Ca and P are needed, use monocalcium phosphate, dicalcium phosphate, tricalcium phosphate, defluorinated phosphate, or bone meal. | Because cereal grains (which largely form the diet of swine) are low in Ca, swine are more apt to suffer from Ca deficiencies than from any of the other minerals except salt.<br>*Most favorable Ca:P ratio is between 1:1 and 1.5:1.<br>Sow's milk contains a Ca:P ratio of 1.3:1. |
| Variable according to class, age, and weight of swine (see Tables 23-1 and 23-2).<br>Phosphorus (P) | Variable according to class, age, and weight of swine (see Tables 23-3 and 23-4). | Self-feed suitable mineral, or add P to the ration as required to bring level of total ration slightly above requirements. | Monosodium phosphate, disodium phosphate, sodium tripolyphosphate, ammonium phosphate solution, or feed-grade phosphoric acid.<br>Where both Ca and P are needed, use monocalcium phosphate, dicalcium phosphate, tricalcium phosphate, defluorinated phosphate, or bone meal. | One-half to 2/3 of P in grains is in phytate form, of which 20–50% is not available to swine; although fairly good utilization of phytate P is achieved through action of enzyme phytase(s) in the intestine.<br>*Most favorable Ca:P ratio is between 1:1 and 1.5:1.<br>Sow's milk contains a Ca:P ratio of 1.3:1. |
| Exact requirement is not known.<br>Magnesium (Mg) | | *181.8 mg/lb (*400 mg/kg*) as-fed ration. | Magnesium oxide or magnesium sulfate. | Practical rations adequate in magnesium. |
| *Between 2.5 and 5.0 g daily for 100-lb (*45-kg*) pig.<br>Potassium (K) | *0.26% as-fed ration for 10-lb (*4.5-kg*) pig.<br>*0.23–0.28% as-fed ration for 35-lb (*16-kg*) pig. | | Corn contains 0.27% potassium, and other cereals contain 0.42–0.49% potassium. | Deficiency of potassium not observed in practical rations. |
| No requirements for cobalt have been established.<br>Cobalt (Co) | | *Cobalt levels of about 0.045 mg/lb (*0.1 mg/kg*) are often added to swine feeds (as-fed basis). | Cobalt chloride, cobalt sulfate, cobalt oxide, or cobalt carbonate. Also, several good commercial minerals are on the market. | |

(*Continued*)

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Table 2-4
Swine Mineral Chart
Page 3

| Minerals Which May Be Deficient Under Normal Conditions | Conditions Usually Prevailing Where Deficiencies Are Reported | Function of Mineral | Some Deficiency Symptoms |
|---|---|---|---|
| **Copper** (Cu) | Suckling pigs kept off soil. | Essential element in a number of enzyme systems and necessary for synthesizing hemoglobin and preventing nutritional anemia. Hemoglobin serves as a carrier of oxygen throughout the body. | Slow growth, poor hair and skin condition, lameness and stiffness, weakened bone structure, weak and crooked legs, and anemia. |
| **Iodine** (I) | Iodine-deficient areas or soils (in northwestern U.S. and in the Great Lakes region) when iodized salt is not fed.<br>Where feeds come from iodine-deficient areas. | Needed by the thyroid gland for making thyroxin, an iodine-containing hormone which controls the rate of body metabolism or heat production. | Loss of appetite, slow growth, poor hair and skin condition, impaired breeding or gestation, offspring dead or weak at birth, pigs hairless at birth, and/or goiter. |
| **Iron** (Fe) | Suckling pigs kept off soil. | Necessary for formation of hemoglobin, an iron-containing compound which enables the blood to carry oxygen. Iron is also important to certain enzyme systems. | Loss of appetite, slow growth, poor hair and skin condition, high mortality in young pigs, susceptibility to disease, thumps (characterized by labored breathing), and anemia.<br>The number of grams of hemoglobin per 100 ml of blood is a rapid, reliable indicator of the iron status of the pig. |
| **Manganese** (Mn) | | Functions with many enzymes in soft tissue metabolism.<br>Necessary for growth, bone structure, and reproduction. | Lameness or stiffness, weakened bone structure, impaired reproduction, pigs dead or weak at birth, reduced skeletal growth, increased backfat, and irregular estrus. |
| **Selenium** (Se) | A selenium-deficient diet. | Functions with glutathione peroxidase, an enzyme which enables the tripeptide glutathione to perform its role as a biological antioxidant in the body.<br>Involved in vitamin E absorption and/or retention. Also, a required nutrient in its own right. | Loss of appetite, slow growth, marked necrosis of the liver, a yellowish-brown discoloration of body fat, and sudden death. |
| **Zinc** (Zn) | High levels of calcium in relation to zinc levels impair zinc utilization and increase the requirements. | Zinc is a component of several enzyme systems, including peptidases and carbonic anhydrase.<br>Also, zinc is required for normal protein synthesis and metabolism and is a component of insulin. | Parakeratosis or swine dermatitis, pigs have a mangy look, reduced appetite, unthriftiness, poor growth rate, and diarrhea, and there may be vomiting. It affects swine of all ages. |

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[1] As used herein, the distinction between "mineral requirements" and "recommended allowances" is as follows: In mineral requirements, no margins of safety are included intentionally; whereas in recommended allowances, margins of safety are provided in order to compensate for variations in feed composition, environment, and possible losses during storage or processing.

Where preceded by an asterisk, the mineral requirements, recommended allowances, and other facts presented herein were taken from *Nutrient Requirements of Swine*, No. 2, 7th rev. ed., NRC—National Academy of Sciences, 1973.

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Table 2-4
Swine Mineral Chart
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| Mineral Requirements[1] | | Recommended Allowances[1] | Practical Sources of the Mineral | Comments |
|---|---|---|---|---|
| **Minerals/ Animal/Day** | **Mineral Content of Ration** | | | |
| *0.045-0.068 mg/lb (*0.1-0.15 mg/kg*) body weight.<br>Copper (Cu) | *2.7 mg/lb (*6 mg/kg*) as-fed ration for baby pigs. | | Copper sulfate, copper carbonate, and copper oxide are about equally effective. | Beyond the suckling period, natural feedstuffs usually contain enough copper.<br>*Apart from the role of copper as an essential trace element, much higher levels (56.8-113.6 mg/lb, or *125-250 mg/kg*) in the diet have been shown to support increased rate and efficiency of gains of pigs to breeding age. |
| *For pregnant sows: 2.0 mcg/lb (*4.4 mcg/kg*) body wt. daily, and somewhat less for growing swine.<br>Iodine (I) | *0.09 mg/lb (*0.2 mg/kg*) as-fed ration. | *Use stabilized, iodized salt containing 0.007% iodine incorporated at 0.5% of grain ration or fed free-choice.<br>0.09 mg/lb (*0.2 mg/kg*) of as-fed ration. | Stabilized iodized salt containing 0.007% iodine. | |
| *Newborn pigs require 7 mg of absorbed iron daily for normal growth.<br>Iron (Fe) | *36.36 mg/lb (*80 mg/kg*) of as-fed ration for baby pigs. | *36.4 mg/lb (*80 mg/kg*) as-fed ration for baby pigs.<br>Suitable iron preparations, injected at levels of 150-200 mg into baby pigs at 1-3 days of age, will prevent anemia due to iron deficiency. | Ferrous sulfate or ferric ammonium citrate.<br>For the prevention or treatment of anemia in young pigs, either (1) place a little uncontaminated sod (topsoil, from an area where hogs have not run for years) in the corner of the pen daily, (2) inject a suitable iron preparation at a level of 150-200 mg into baby pigs at 1-3 days of age, (3) swab the sow's udder with iron solution, (4) give an iron-copper pill, or (5) allow access to oral iron preparations. In addition, the pigs should be encouraged to eat a grain ration as soon as they are old enough. | Newborn pigs contain an average of 47 mg of iron.<br>Iron has a detoxifying effect when added to gossypol-containing diets. Add iron from soluble source to free gossypol at a weight ratio of 1:1.<br>Milk is deficient in iron (sow's milk contains an average of 1 mg of iron/liter) and copper. Pigs should be encouraged to eat grain ration as soon as old enough.<br>Iron levels of 2,273 mg/lb (*5,000 mg/kg*) of diet are considered toxic. |
| Minimum requirements for manganese not well defined.<br>Manganese (Mn) | | *9.1 mg/lb (*20 mg/kg*) as-fed ration. | Manganous oxide. | Manganese is usually present in adequate amounts in most swine rations, but it may not be adequate for the optimum reproductive performance of sows. |
| Selenium (Se) | *0.045 mg/lb (*0.10 mg/kg*) of as-fed ration. | Selenium in either sodium selenite or sodium selenate at rate of 0.1 ppm of complete as-fed ration.<br>*Injection of 5 mg sodium selenite or barium selenate every 28 days will prevent selenium deficiency. | Sodium selenite or sodium selenate. | Selenium is related to vitamin E absorption.<br>*Caution:* Toxic level of selenium is in range of 2.27-3.63 mg/lb (*5-8 mg/kg*) selenium in the feed.<br>The U.S. Food and Drug Administration approved the addition of selenium to swine diets in 1974, at a level of 0.1 ppm. |
| The requirement for zinc is very low.<br>Zinc (Zn) | *22.7 mg/lb (*50 mg/kg*) of as-fed ration containing soybean protein.<br>*When calcium level of ration is 1½-2%, double the zinc allowance. | | Zinc carbonate or zinc sulfate. | It has been shown that parakeratosis is caused by zinc and calcium forming an unavailable complex.<br>Zinc toxicosis has been produced by zinc or zinc carbonate at level of 909 mg/lb (*2,000 mg/kg*) of corn-soybean meal. |

*Note:* *Mineral recommendations for all classes and ages of swine, especially those fed unmixed rations or on pastures are—*

1. *Where animals are on liberal grain feeding*—Provide free access to a 2-compartment mineral box, with (a) trace mineralized salt in one side, and (b) in the other side, a mixture of ⅓ trace mineralized salt (salt included for purposes of palatability), ⅓ defluorinated phosphate or steamed bone meal, and ⅓ ground limestone or oystershell flour.

2. *Where animals are primarily on roughage (pasture, hay, and/or silage)*—Provide free access to a 2-compartment mineral box, with (a) trace mineralized salt in one side (salt included for purposes of palatability), and (b) in the other side, a mixture of ⅓ trace mineralized salt and ⅔ defluorinated phosphate or steamed bone meal.

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## Table 2-5
## Swine Vitamin Requirements

| Vitamin Which May Be Deficient Under Normal Conditions | Conditions Usually Prevailing Where Deficiencies Are Reported | Function of Vitamin | Some Deficiency Symptoms |
|---|---|---|---|
| **Choline** | Baby pigs fed a synthetic milk diet containing not more than 0.8% methionine. | Involved in nerve impulses. A component of phospholipids.<br>Donor of methyl groups. | Unthriftiness, lack of coordination, spraddled hind legs at birth, fatty infiltration of the liver, poor reproduction, poor lactation, and decreased survival of the young. |
| **Folacin** (folic acid) | | Related to $B_{12}$ metabolism.<br>Metabolic reactions involving incorporation of single carbon units into larger molecules. | Poor growth.<br>Macrocytic anemia. |
| **Niacin** (nicotinic acid) | | Required by all living cells, and an essential component of important metabolic enzyme systems involved in glycolysis and tissue respiration. | Loss of appetite and decreased gain, followed by diarrhea, occasional vomiting, dermatitis, and loss of hair. |
| **Pantothenic acid** | Long period of inadequate pantothenic acid intake. | Functions in the oxidation of food materials.<br>Essential in fat and cholesterol synthesis. | A goose-stepping gait, loss of appetite, poor growth, diarrhea, reduced fertility, and breeding failure. |
| **Pyridoxine** ($B_6$) | | As coenzyme in protein and nitrogen metabolism.<br>Involved in red blood cell formation.<br>Important in endocrine systems. | Loss of appetite and poor growth, unsteady gait, anemia, and epilepticlike fits (convulsions). |
| **Riboflavin** ($B_2$) | | A component of enzyme systems essential to normal metabolic processes. | Loss of appetite, poor growth, rough hair coat, diarrhea, reproductive failure in the sow, pigs dead or weak at birth, and crooked legs and incoordination. |
| **Thiamin** ($B_1$) | | As a coenzyme in energy metabolism.<br>Promotes appetite and growth, required for normal carbohydrate metabolism, and aids reproduction. | Loss of appetite and poor growth, diarrhea, dead or weak offspring, slow pulse, low body temperature, and flabby heart. |
| **Vitamin C** (ascorbic acid) | | | |

**(Continued)**

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Table 2-5
Swine Vitamin Requirements
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| Vitamin Requirements[1] | | Recommended Allowances[1] | Practical Sources of the Vitamin | Comments |
|---|---|---|---|---|
| Vitamin/Animal/Day | Vitamin Content of Ration | | | |
| Variable, according to class, age, and weight of swine (see Tables 23-1 and 23-2).<br>*Choline at level of 9.09 mg/lb (*20 mg/kg*) body weight has prevented symptoms of deficiency in sows. | Variable, according to class, age, and weight of swine (see Tables 23-3 and 23-4).<br>Choline at level of 0.1% of the as-fed ration has prevented symptoms of deficiency in baby pigs.<br>Choline | | Choline chlorides or choline dihydrogen. | Choline content of normal feeds is usually sufficient.<br>But studies have shown that more live pigs are born and weaned when sows receive supplemental choline throughout gestation. |
| Requirements have not been determined.<br>Folacin | | | Practical swine rations are believed to be adequate in folacin.<br>Synthetic folacin. | |
| Variable, according to class, age, and weight of swine (see Tables 23-1 and 23-2).<br>Niacin | Variable, according to class, age, and weight of swine (see Tables 23-3 and 23-4). | | | Niacin occurs in corn, wheat, and milo in bound form; hence, it may be unavailable to the pig. Also, the tryptophan level affects the niacin requirement because of the conversion of tryptophan to niacin. |
| Variable, according to class, age, and weight of swine (see Tables 23-1 and 23-2). | Variable, according to class, age, and weight of swine (see Tables 23-3 and 23-4). | Pantothenic Acid | Calcium pantothenate (only the D isomer has vitamin activity).<br>Dried milk products, condensed fish solubles, and alfalfa meal. | Widely distributed and occurs in practically all feedstuffs. However, the quantity present may not always be sufficient to meet the needs of the pig. |
| Variable, according to class, age, and weight of swine (see Tables 23-1 and 23-2).<br>Pyridoxine ($B_6$) | Variable, according to class, age, and weight of swine (see Tables 23-3 and 23-4). | | Vitamin $B_6$.<br>Cereal grains and their by-products.<br>Rice bran.<br>Green pastures.<br>Well-cured alfalfa hay.<br>Yeast. | Pyridoxine content of normal feeds is usually sufficient. |
| Variable, according to class, age, and weight of swine (see Tables 23-1 and 23-2). | Variable, according to class, age, and weight of swine (see Tables 23-3 and 23-4). | Riboflavin | Synthetic riboflavin.<br>Green pastures.<br>Milk and milk products.<br>Meat scraps and fish meal. | Riboflavin is apt to be lacking in swine rations. |
| Variable, according to class, age, and weight of swine (see Tables 23-1 and 23-2).<br>thiamin | Variable, according to class, age, and weight of swine (see Tables 23-3 and 23-4). | | Thiamin hydrochloride.<br>Green pastures.<br>Well-cured, green leafy hays.<br>Cereal grains.<br>Peas.<br>Brewers' yeast. | Thiamin content of normal feeds is usually sufficient. |
| Vitamin C | | | Crystalline ascorbic acid. | Normally, pigs are able to synthesize vitamin C in amounts sufficient to meet their requirements. However, there is limited evidence that dietary ascorbic acid is beneficial under some conditions. |

(*Continued*)

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Table 2-5
Swine Vitamin Requirements
Page 3

| Vitamin Which May Be Deficient Under Normal Conditions | Conditions Usually Prevailing Where Deficiencies Are Reported | Function of Vitamin | Some Deficiency Symptoms |
|---|---|---|---|
| Either there is sufficient intestinal synthesis or the pig does not need the following B vitamins: inositol and para-aminobenzoic acid. | | | |
| Unidentified factors, both organic and inorganic. | | Contribute factor or factors, or correct imbalances. | |

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[1] As used herein, the distinction between "vitamin requirements" and "recommended allowances" is as follows: In vitamin requirements, no margins of safety are included intentionally, whereas in recommended allowances, margins of safety are provided in order to compensate for variations in feed composition, environment, and possible losses during storage or processing.

**(Continued)**

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Table 2-5
Swine Vitamin Requirements
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| Vitamin Requirements[1] | | Recommended Allowances[1] | Practical Sources of the Vitamin | Comments |
|---|---|---|---|---|
| Vitamins/ Animal/Day | Vitamin Content of Ration | | | |
| | | | | |
| | | | Distillers' dried solubles, fish solubles, dried whey, grass juice concentrate, green pasture, high-quality grass silage, soil, alfalfa meal, brewers' dried yeast, liver, and pasture. | Unidentified factors contribute other than known nutrients of benefit to growing pigs and gestating-lactating sows. |

[1] Where preceded by an asterisk, the vitamin requirements, recommended allowances, and other facts presented herein were taken from *Nutrient Requirements of Swine*, No. 2, 7th rev. ed., NRC National Academy of Sciences, 1973.

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Table 2-6
Swine Vitamin Chart

| Vitamin Which May Be Deficient Under Normal Conditions | Conditions Usually Prevailing Where Deficiencies Are Reported | Function of Vitamin | Some Deficiency Symptoms |
|---|---|---|---|
| **Fat-soluble vitamins:**<br>A | Absence of green forages, either pasture or green hay—especially under drylot conditions.<br>Where the ration consists chiefly of white corn, milo, barley, wheat, oats, or rye; or by-products of these grains; or yellow corn that has been stored in excess of a year. | Essential for normal maintenance and functioning of the epithelial tissues, particularly of the eye and the respiratory, digestive, reproductive, nerve, and urinary systems. | Night and day blindness, very irritable, poor appetite and slow growth, lameness, incoordination of movement, loss of control of the hind legs, and weakness of the back.<br>Low resistance to respiratory infections.<br>Sows may fail to come in heat, may resorb their fetuses, and may have young born dead with various deformities and defects. |
| D | Limited sunlight and/or limited quantities of sun-cured hay in drylot rations. | Aids in assimilation and utilization of calcium and phosphorus, and necessary in the normal bone development of animals—including the bones of the fetus. | Rickets in young pigs, or osteomalacia in mature hogs. Both conditions result in large joints and weak bones. |
| E (tocopherol) | Diets containing excessive amounts of highly unsaturated fatty acids or oxidized fats.<br>Swine feeds low in selenium, especially where swine are raised in confinement without access to forages. | Antioxidant.<br>Muscle structure.<br>Reproduction. | Loss of appetite and slow growth.<br>Increased embryonic mortality and muscular incoordination in suckling pigs from sows fed vitamin E-deficient diets during gestation and lactation. |
| K | Moldy feed.<br>High antibiotic levels, which may make for inadequate intestinal synthesis of vitamin K. | Essential for prothrombin formation and blood clotting. | Bleeding condition in young pigs, which responds to injection or oral administration of vitamin K.<br>Slow growth and hyperirritability. |
| **Water-soluble vitamins:**<br>$B_{12}$ |  | Numerous metabolic functions, and essential for normal growth and reproduction in swine. | Poor growth, lowered reproduction, and anemia. |
| **Biotin** | When pigs are fed (1) dried, raw egg white, or (2) sulfathalidine.<br>When young pigs are fed a diet devoid of biotin. |  | Alopecia, spasticity of the hind legs, cracks in the feet, and a dermatosis. |

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Table 2-6
Swine Vitamin Chart
Page 2

| Vitamin Requirements[1] | | Recommended Allowances[1] | Practical Sources of the Vitamin | Comments |
|---|---|---|---|---|
| Vitamins/Animal/Day | Vitamin Content of Ration | | | |
| Variable, according to class, age, and weight of swine (see Tables 23-1 and 23-2).<br>Fat-soluble Vitamins<br>A | Variable, according to class, age, and weight of swine (see Tables 23-3 and 23-4). | Add vitamin A to the ration to bring level of total ration slightly above requirements. | Stabilized vitamin A. | One mg of beta-carotene from natural feedstuffs is equal to approximately 500 IU of vitamin A activity for swine.<br>Meals from artificially dehydrated forages are much higher in carotene than sun-cured products.<br>Taken together, liver storage levels of plasma vitamin A and pressure of cerebrospinal fluid give reliable estimates of the vitamin A status of the pig. |
| Variable, according to class, age, and weight of swine (see Tables 23-1 and 23-2).<br>D | Variable, according to class, age, and weight of swine (see Tables 23-3 and 23-4). | Add vitamin D to the ration to bring level of total ration slightly above requirements. | Vitamin $D_2$ (irradiated ergosterol) and vitamin $D_3$ (irradiated 7-dehydrocholesterol) are similar in biological activity for swine.<br>Irradiated yeast.<br>Exposure to sunlight.<br>Sun-cured hay (10% alfalfa in the total ration will normally supply sufficient vitamin D). | Grains, grain by-products, and high-protein feedstuffs are practically devoid of vitamin D; therefore, unless swine are exposed daily to the ultraviolet rays of the sun, the diet should be fortified with vitamin D.<br>When animals are exposed to direct sunlight, the ultraviolet light produces vitamin D from traces of cholesterol in the skin.<br>The vitamin D requirement is less when a proper balance of calcium and phosphorus exists in the ration.<br>One IU vitamin D is defined as the biological activity of 0.025 mg of crystalline vitamin $D_3$. |
| Unknown.<br>E (tocopherol) | | *5 IU/lb (*11 IU/kg*) of diet. | High-quality green feeds, whole cereal grains, and the germ of cereal grains. Alpha-tocopherol. | Tocopherols differ in their biological activity, with *d*-alpha-tocopherol being the most active. One IU of vitamin E is the equivalent in biopotency of 1 mg *dl*-alpha-tocopherol acetate. |
| K | | *If there is evidence of a vitamin K deficiency, supplement the as-fed ration with menadione at levels of 1.0 mg/lb (*2.2 mg/kg*). | Under practical conditions, the vitamin K requirement is met by vitamin K in feedstuffs and by intestinal synthesis. | |
| Variable, according to class, age, and weight of swine (see Tables 23-1 and 23-2).<br>Water-soluble Vitamins<br>$B_{12}$ | Variable, according to class, age, and weight of swine (see Tables 23-3 and 23-4). | | Synthetic $B_{12}$.<br>Protein supplements of animal origin.<br>Fermentation products. | Vitamin $B_{12}$ is apt to be lacking in swine rations.<br>Synthesis of vitamin $B_{12}$ by intestinal flora may supplement dietary sources.<br>$B_{12}$ contains the trace element cobalt; hence, the synthesis of $B_{12}$ in the intestines is dependent on the presence of cobalt in the feed. This may be the major, if not the only, function of cobalt as an essential nutrient. |
| Biotin | | | | Very young pigs (under about 3 weeks of age) do not produce enough biotin until they develop an intestinal flora capable of synthesizing it.<br>The protein avidin in raw egg white makes biotin unavailable to pigs. Heat treatment inactivates avidin and makes egg white safe for feeding to pigs. |

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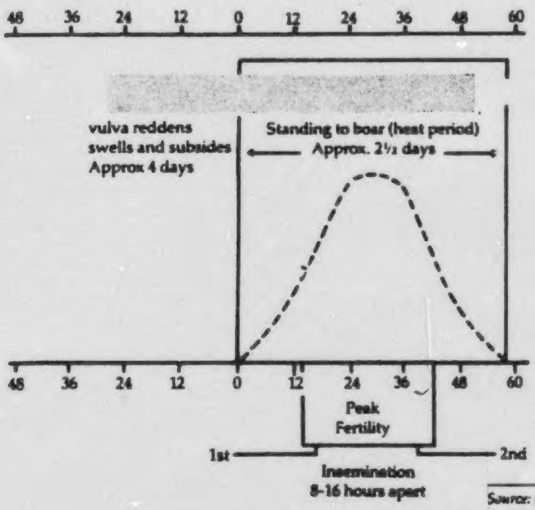
# SWINE MANAGEMENT

## Reproductive Cycle

Estrus (heat) first occurs in exotic breeds of swine that are well fed on a nutritious diet, at about 5 months of age. The arrival of the first estrus is affected by both breed and nutrition. Local breeds of swine that are free ranging may come into heat later. Gilts and sows come into heat approximately every 21 days. The estrus may last from 1 to 3 days. It is not a good idea to breed a gilt on her first estrus. She will make better brood sow if you first breed her on her third estrus at approximately 8 months of age. This will make her about 1 year old before her first farrowing. If you have young gilts and boars mixed, they should be separated, if possible, by the fifth month if you are to retain control over breeding. A sow, after farrowing, will not have another estrus until 3-5 days after weaning of her litter. If the sow is healthy and receiving an adequate ration, she may be rebred on her first estrus after weaning. Listed below are the signs indicating estrus:

1. Flushed and swollen vulva. This will occur 1 or 2 days prior to standing heat.
2. Nervousness and more than the usual amount of grunting.
3. A tacky vaginal discharge that may be more readily felt than seen.
4. A sow or gilt in "standing heat" stands stock still when you press down on her lower back.
5. Riding or mounting among a group of sows. As sows come into heat, they will be mounted by others, but will not stand still until they are in good standing heat. While in standing heat, they may mount other sows as well. The scent of a boar is also helpful in detecting standing heat.

SOW HEAT AND FERTILITY PERIODS



Source: Agriculture Canada

## Gestation

The 114 days of gestation cannot be regulated by nutrition and management of the sow. If possible, it is a good idea to have the sow penned separately during gestation. For additional information about nutrition of the sow during the gestation refer to the nutrition section for swine.

## Lactation

For information on the nutrition requirements of a lactating sow refer to the nutrition section. Sows may nurse their litter on either side as they are laying down, from a sitting position, or even standing up. Piglets will establish an order of dominance along the line of teats. The larger piglets will gain the advantage of sucking a front teat (which has more milk than the rear ones) over the runts of the litter which will be left with the rear teats. A sow will not be able to raise more piglets than she has functioning teats. Extra piglets will need to be hand fed or placed with another litter. Any piglet that has not received colostrum within the first day of life will not survive. To avoid rejection by the sow of an orphaned piglet you can mask the scent of the piglet by placing a smelly cologne on the nose of the sow, the other piglets, and the new piglet so that the sow does not detect a new scent. It is quite difficult to raise an orphaned piglet on a bottle.

## Weaning

The length of time that you have the sow nurse the piglets before weaning is dependent on several factors including: local markets, the breed of the pigs, the quality and quantity of feed available, and how quickly you wish to rebreed the sow. Piglets can be weaned as early as 3 weeks (if other feeds are available) or as late as 12 weeks. The feed ration for 3 week old piglets that are to be weaned should be 20 to 22% protein. When weaning, remove the sow from the piglets and reduce her feed and take away her water for one day in order to reduce milk production.

## Post-Weaning Heat

As mentioned earlier, the sow will return to estrus 3-5 days after weaning. The decision about when to rebreed should be based on, primarily, the diet of the sow. If she is not overly stressed and on a good ration she can be rebreed right away.

## Breeding-Mating

If possible (which it is not in a free-ranging environment) the breeding of pigs should be timed so that the sow farrows and is lactating around the end of the rainy season when feed supplies would be the most abundant. This is advisable in order to match the times of peak availability of feeds with the peak nutrient demands in production. The following points should be kept in mind concerning the breeding of swine:

1. Gilts and boars can be used for breeding once they have reached 50% of the mature body weight.

2. Breeding animals should not be overfed and allowed to become fat or they will be less productive.

3. Weak legs, heavy flanks, jowls, and underbelly, and a lot of backfat are indicative of poor breeding stock.

4. A boar should be bred at least 3 times a week. Boars used less often than this will have low fertility in their first ejaculate.

5. Gilts should not be bred on their first estrus.

6. Flushing can be used to increase ovulation and fertility in the sow. Read about flushing in the section on swine nutrition.

7. Temperatures of 30°C or higher greatly reduce sperm fertility, ovulation rate, and libido. Breeding during the hot season is not advisable due to reduced conception rates. If mating is to occur during the hot season, it should be done in the cool of the early morning or late evening.

8. Pigs are slow motion lovers. The boar may reach ejaculation within a few minutes time, but it will last for more than 5 minutes while the boar delivers at least one cup of semen into the sow. The penis of a pig is cork-screwed in shape.

9. While one boar may be adequate for 10-15 sows they live a short productive life (5 to 6 years) before potency reduces and they should be culled.

10. A sow should be bred twice during estrus at approximately 12-hour intervals. The second breeding will increase the size of the litter.

11. Large boars may weigh too much for smaller gilts causing them to fall when the boar mounts. If this is the case, the volunteer or farmer may be needed to assist with the breeding (this is called hand breeding) in order to ensure that the boar is able to penetrate and that mating does occur.

## Farrowing

Farrowing refers to the act of sows giving birth. It is important that sows have someone present during farrowing to assist. This is particularly true for moderate to high production operations where money has been invested in the sow and production depends on the size of the litter she produces. In free-ranging environments (with little or no investment) assisting during farrowing is less important and also less possible. The purpose of being present during the farrowing is to assist the piglets as they are born in order to reduce losses through mortality.

You should place the sow in the farrowing crate 2 to 3 days before she is scheduled to give birth. If you will recall, the gestation time for sows is 114 days (+ or - 2 days). Another way to remember this is that gestation takes 3 months, 3 weeks, and 3 days. There are signs that the sow will give which indicate the immediacy of the upcoming farrowing. They are:

- Sows will fill or "bottom out" during the third month of gestation.
- The udder will begin to develop and fill 7 to 10 days before farrowing.
- You should be able to squeeze colostrum from a teat within 24 hours of farrowing.
- As the hour of farrowing nears the sow will become nervous, restless, and may grunt or moan a lot. Normally docile sows may also become aggressive - therefore it is important that they are securely enclosed in the farrowing crate.
- The sow may get up and down or roll repeatedly from one side to the other as farrowing nears.
- The placental pouch may break causing a discharge of bloody fluid moments before the first piglet is farrowed. During this time, stay calm, sit down and take it easy because it will take a while. If your sow is farrowing at night (as they always seem to) relax, drink a beverage, and take it easy.

### Steps to take prior to farrowing

- Get all of your needed materials on hand. Check the materials list.
- Arrange for a light source in case she farrows at night.
- Place the sow in the farrowing crate.
- Take the sow off feed the last 24 hours before farrowing.
- Arrange to have someone check on the sow every hour aruond the clock.
- Clean the farrowing crate and disinfect it if possible. Pine oil or another disinfectant should be used on the floor at the rear of the sow.

Place a dry bedding material at the rear of the farrowing crate.

SWINE GESTATION TABLE - 115 DAYS

**Swine Gestation Table-115 Days**

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bred Jan.<br>Farrow April | 1<br>26 | 2<br>27 | 3<br>28 | 4<br>29 | 5<br>30 | 6<br>1 | 7<br>2 | 8<br>3 | 9<br>4 | 10<br>5 | 11<br>6 | 12<br>7 | 13<br>8 | 14<br>9 | 15<br>10 | 16<br>11 | 17<br>12 | 18<br>13 | 19<br>14 | 20<br>15 | 21<br>16 | 22<br>17 | 23<br>18 | 24<br>19 | 25<br>20 | 26<br>21 | 27<br>22 | 28<br>23 | 29<br>24 | 30<br>25 | 31<br>26 | Jan.<br>May |
| Bred Feb.<br>Farrow May | 1<br>27 | 2<br>28 | 3<br>29 | 4<br>30 | 5<br>31 | 6<br>1 | 7<br>2 | 8<br>3 | 9<br>4 | 10<br>5 | 11<br>6 | 12<br>7 | 13<br>8 | 14<br>9 | 15<br>10 | 16<br>11 | 17<br>12 | 18<br>13 | 19<br>14 | 20<br>15 | 21<br>16 | 22<br>17 | 23<br>18 | 24<br>19 | 25<br>20 | 26<br>21 | 27<br>22 | 28<br>23 | ---<br>--- | ---<br>--- | ---<br>--- | Feb.<br>June |
| Bred Mar.<br>Farrow June | 1<br>24 | 2<br>25 | 3<br>26 | 4<br>27 | 5<br>28 | 6<br>29 | 7<br>30 | 8<br>1 | 9<br>2 | 10<br>3 | 11<br>4 | 12<br>5 | 13<br>6 | 14<br>7 | 15<br>8 | 16<br>9 | 17<br>10 | 18<br>11 | 19<br>12 | 20<br>13 | 21<br>14 | 22<br>15 | 23<br>16 | 24<br>17 | 25<br>18 | 26<br>19 | 27<br>20 | 28<br>21 | 29<br>22 | 30<br>23 | 31<br>24 | Mar.<br>July |
| Bred April<br>Farrow July | 1<br>25 | 2<br>26 | 3<br>27 | 4<br>28 | 5<br>29 | 6<br>30 | 7<br>31 | 8<br>1 | 9<br>2 | 10<br>3 | 11<br>4 | 12<br>5 | 13<br>6 | 14<br>7 | 15<br>8 | 16<br>9 | 17<br>10 | 18<br>11 | 19<br>12 | 20<br>13 | 21<br>14 | 22<br>15 | 23<br>16 | 24<br>17 | 25<br>18 | 26<br>19 | 27<br>20 | 28<br>21 | 29<br>22 | 30<br>23 | ---<br>--- | April<br>Aug. |
| Bred May<br>Farrow Aug. | 1<br>24 | 2<br>25 | 3<br>26 | 4<br>27 | 5<br>28 | 6<br>29 | 7<br>30 | 8<br>31 | 9<br>1 | 10<br>2 | 11<br>3 | 12<br>4 | 13<br>5 | 14<br>6 | 15<br>7 | 16<br>8 | 17<br>9 | 18<br>10 | 19<br>11 | 20<br>12 | 21<br>13 | 22<br>14 | 23<br>15 | 24<br>16 | 25<br>17 | 26<br>18 | 27<br>19 | 28<br>20 | 29<br>21 | 30<br>22 | 31<br>23 | May<br>Sept. |
| Bred June<br>Farrow Sept. | 1<br>24 | 2<br>25 | 3<br>26 | 4<br>27 | 5<br>28 | 6<br>29 | 7<br>30 | 8<br>1 | 9<br>2 | 10<br>3 | 11<br>4 | 12<br>5 | 13<br>6 | 14<br>7 | 15<br>8 | 16<br>9 | 17<br>10 | 18<br>11 | 19<br>12 | 20<br>13 | 21<br>14 | 22<br>15 | 23<br>16 | 24<br>17 | 25<br>18 | 26<br>19 | 27<br>20 | 28<br>21 | 29<br>22 | 30<br>23 | ---<br>--- | June<br>Oct. |
| Bred July<br>Farrow Oct. | 1<br>24 | 2<br>25 | 3<br>26 | 4<br>27 | 5<br>28 | 6<br>29 | 7<br>30 | 8<br>31 | 9<br>1 | 10<br>2 | 11<br>3 | 12<br>4 | 13<br>5 | 14<br>6 | 15<br>7 | 16<br>8 | 17<br>9 | 18<br>10 | 19<br>11 | 20<br>12 | 21<br>13 | 22<br>14 | 23<br>15 | 24<br>16 | 25<br>17 | 26<br>18 | 27<br>19 | 28<br>20 | 29<br>21 | 30<br>22 | 31<br>23 | July<br>Nov. |
| Bred Aug.<br>Farrow Nov. | 1<br>24 | 2<br>25 | 3<br>26 | 4<br>27 | 5<br>28 | 6<br>29 | 7<br>30 | 8<br>1 | 9<br>2 | 10<br>3 | 11<br>4 | 12<br>5 | 13<br>6 | 14<br>7 | 15<br>8 | 16<br>9 | 17<br>10 | 18<br>11 | 19<br>12 | 20<br>13 | 21<br>14 | 22<br>15 | 23<br>16 | 24<br>17 | 25<br>18 | 26<br>19 | 27<br>20 | 28<br>21 | 29<br>22 | 30<br>23 | 31<br>24 | Aug.<br>Dec. |
| Bred Sept.<br>Farrow Dec. | 1<br>25 | 2<br>26 | 3<br>27 | 4<br>28 | 5<br>29 | 6<br>30 | 7<br>31 | 8<br>1 | 9<br>22 | 10<br>3 | 11<br>4 | 12<br>5 | 13<br>6 | 14<br>7 | 15<br>8 | 16<br>9 | 17<br>10 | 18<br>11 | 19<br>12 | 20<br>13 | 21<br>14 | 22<br>15 | 23<br>16 | 24<br>17 | 25<br>18 | 26<br>19 | 27<br>20 | 28<br>21 | 29<br>22 | 30<br>23 | ---<br>--- | Sept.<br>Jan. |
| Bred Oct.<br>Farrow Jan. | 1<br>24 | 2<br>25 | 3<br>26 | 4<br>27 | 5<br>28 | 6<br>29 | 7<br>30 | 8<br>31 | 9<br>1 | 10<br>2 | 11<br>3 | 12<br>4 | 13<br>5 | 14<br>6 | 15<br>7 | 16<br>8 | 17<br>9 | 18<br>10 | 19<br>11 | 20<br>12 | 21<br>13 | 22<br>14 | 23<br>15 | 24<br>16 | 25<br>17 | 26<br>18 | 27<br>19 | 28<br>20 | 29<br>21 | 30<br>22 | 31<br>23 | Oct.<br>Feb. |
| Bred Nov.<br>Farrow Feb. | 1<br>24 | 2<br>25 | 3<br>26 | 4<br>27 | 5<br>28 | 6<br>1 | 7<br>2 | 8<br>3 | 9<br>4 | 10<br>5 | 11<br>6 | 12<br>7 | 13<br>8 | 14<br>9 | 15<br>10 | 16<br>11 | 17<br>12 | 18<br>13 | 19<br>14 | 20<br>15 | 21<br>16 | 22<br>17 | 23<br>18 | 24<br>19 | 25<br>20 | 26<br>21 | 27<br>22 | 28<br>23 | 29<br>24 | 30<br>25 | ---<br>--- | Nov.<br>Mar. |
| Bred Dec.<br>Farrow Mar. | 1<br>26 | 2<br>27 | 3<br>28 | 4<br>29 | 5<br>30 | 6<br>31 | 7<br>1 | 8<br>2 | 9<br>3 | 10<br>4 | 11<br>5 | 12<br>6 | 13<br>7 | 14<br>8 | 15<br>9 | 16<br>10 | 17<br>11 | 18<br>12 | 19<br>13 | 20<br>14 | 21<br>15 | 22<br>16 | 23<br>17 | 24<br>18 | 25<br>19 | 26<br>20 | 27<br>21 | 28<br>22 | 29<br>23 | 30<br>24 | 31<br>25 | Dec.<br>April |

Source: Alabama Cooperative Extension Service, Auburn University, in cooperation with the U.S. Department of Agriculture.

## Farrowing Supplies

1. Dry, clean rags and clean water
2. A small, pointed clean stick
3. Needles (16 & 22 gauge) and oxytocin
4. Glucose or dextrose
5. A wide mouthed bottle of iodine
6. Thread and scissors
7. If it is cold, you may need a heat source (such as a kerosene lamp) to keep the piglets warm.
8. A cardboard or wooden box

## Farrowing Procedure

- Wash the teats of the sow and your hands with warm water and soap.
- Piglets will deliver either feet first or head first--it makes no difference. After the piglet is born, use the stick to poke a hole

through the placental membranes that block the nostrils. Do this immediately so that the piglet can begin breathing.

- If the piglet appears to be breathing O.K., then wipe it off with the rags until completely dry. If it is having difficulty breathing a vigorous massage may help.

- After the piglet is dry and appears to be breathing normally, tie off the umbilical cord about two inches from the body with a thick thread. Tie a tight knot to prevent blood loss and then cut the cord with a sterile knife or scissors about 1/2 inch past the knot. Then use the wide-mouth bottle of iodine to dip the cord that remains and the navel. This will help to prevent possible infections.

- After examining the piglet to make sure it appears to be normal, place it in a box filled with warm and dry bedding while the farrowing continues.

- Repeat this process with other piglets as they are born. The entire farrowing should take 3 to 4 hours with an average of 15 minutes between the birth of each piglet. These times are averages only--any given sow may take more or less time.

- After the birth of the last piglet, the placenta will be delivered indicating the end of the farrowing. It is important to examine the placenta to make sure that it was delivered completely. If portions of the placenta are retained, the sow will become infected. Also, if the placenta appears to be cloudy or has a strong odor, it is possible that the sow already has an infection--such as brucellosis. Read the section on brucellosis.

- Following the last birth, place the piglets with the sow so that they can suckle. Colostrum they receive from the teats the first day of life will determine if they are to survive or not. Colostrum contains many antibodies (such as gammaglobulin) which the piglet must have to survive. Piglets must nurse as soon after birth as is possible.

### Irregular or problem farrowings

If for some reason the sow is not delivering the piglets regularly--the best thing to do is to wait. It is quite difficult to know what to do when it has been 1-2 hours since the last piglet is born. Some sows will birth 2 or 3 piglets quite quickly and then wait an hour or more to birth the next one. I will wait until either a stillborn is delivered or 4 hours have passed before taking any action. There are one of two things to do: either reach into the sow and help to pull the piglet out or give the sow a shot of oxytocin. Both are last resort measures that should not be used by anyone without experience. Any piglet that weighs less than one pound at birth has no chance of survival. Oxytocin is also used to cause a sow to produce milk when she is dry following birth. Follow the directions given for oxytocin contained on the label. Experience is the best teacher for working with farrowing sows.

## Management Techniques for the Care of Piglets

### Needle Teeth

Piglets are born with 8 tiny "needle" teeth that are so named because of their sharp tips. If left unclipped they are used by piglets to compete with one another. The results of such competition are scratched up sow's teats (which can lead to infections and/or mastitis) and the piglets will also chew on the side of each other's faces while competing for a teat and milk. To prevent this scratching and chewing, it is best to clip the ends of these 8 teeth off. Wire cutting pliers or toe nail clippers can be used to remove the top one third of each tooth. Care must be taken to make a clean cut and not break the tooth off because a broken tooth can cause gum infections and abcesses. Hold the piglet's mouth open with your finger far back between the jaws. This is a good technique that can be used in all levels of management.

### Tail Docking

Tail docking is a practice that should be used only in high level management conditions where pigs are being raised in a clean environment and subject to crowded conditions. Chewing results because of the stress of overcrowding. Unlike volunteers on crowded buses, the pigs can not chew tobacco or gum, so they chew on the tails of other pigs near them. Since there is very little feeling in the last third of the tail, it has no idea it is under attack. The result is often crippling infections, open wounds, and decreased production. When the pig is about one week of age (provided that it appears healthy and unstressed) a sharp knife can be used to remove the tip of the tail. It is good to apply a disinfectant, such as iodine, to the wound after clipping. In free-ranging environments where pigs have plenty of room, this is not a necessary nor recommended practice because it opens a wound to infection unnecessarily.

### Iron Shots

Piglets are born quite anemic because of a very low reserve of iron. Iron is needed to produce the oxygen-carrying hemoglobin of the blood. The sow does not provide iron in her milk so piglets must get it from another source. Free-ranging pigs will eat soil while rooting in order to get the needed iron. However, pigs raised in confinement on cement or wood floors need another source. Eating soil exposes the piglets to parasites that may be in the soil as well as the iron. Another way to provide iron to piglets quickly is to give a 1 to 2 cc. injection of a liquid iron solution. Piglets that do not receive this injection of iron within the first two weeks of life will never produce to their genetic potential and should not be considered to be high production (and high investment) pigs. This intramuscular injection should be given in the ham some time within the first three days after farrowing. Avoid veins and arteries when giving this shot. Clean the flesh where the shot is to be given with an alcohol saturated cotton ball before giving the shot. Aspirate (draw back the plunger inside of the syringe) to see if blood enters after poking needle into the ham. If blood has entered the syringe, you have the the needle inside an artery and need to move it. If no blood enters the syringe then depress the plunger and thereby complete the injection. Be sure to wipe the needle down with alcohol before giving the next injection. Syringes and needles should be boiled after finishing with one litter before injecting another.

## Castration

Castration is the practice of removing the testicles from male pigs. Castration is practiced for any of the reasons listed below:

1. Prevents uncontrolled breeding in the herd.

2. Gives the volunteer or farmer control over which boars he/she wishes to use for breeding stock.

3. Some feel that castration can improve the f/g ratio of young boars.

4. Castrated boars are of a more even temperament than uncastrated boars.

5. The meat of a castrated boar has a less gamy or strong flavor than that of an uncastrated boar.

6. In many cultures, people prefer eating a boar if it has been castrated.

Ideally, castration should be done with young piglets when they are two weeks of age. Castrating them at this age is good because smaller wounds are made, healing is rapid, and it is less stressful for the piglet than later.

## Procedure

Castrating a piglet will require two people. The holder places the piglet on its back in his or her lap with the rump facing up. The piglet's hind legs should be held forward. This presses the testicles tightly against the scrotum while at the same time restraining the piglet. If the scrotum area is dirty then wash it first with soap and water, then with a disinfectant solution.

The person doing the cutting presses the testicle against the skin on one side of the scrotum between thumb and forefinger and slices down with a sterile razor blade. Make only one cut and do not saw. Pressure behind the blade should cause the cut to pass through the skin and into the testicle. If the blade cuts the testicle, that's O.K. for it will be gone soon. The cut should be a half-inch to an inch long and low on the scrotum to assure proper drainage of the wound. Remember that low will appear high on the upturned piglet.

As soon as the incision is made, press the testicle out through the opening and pull it gently away from the piglet's body. It will be attached by what appears to be one piece of stringy tissue. Actually, there are 2 vessels closely attached to one another; the sperm duct which is white and the blood vessels which are red. Cut through the white sperm cord. The blood vessels should be snapped off as long as possible and close to the body. To do this, merely keep pulling the vessels out until resistance from within causes the tissues to separate. I know this sounds gruesome and it seems to place as much trauma on the trainee as it does the piglet. Both seem to recover at the same time. It is, however, a good technique because it snaps the artery back into the body cavity, closes off the blood vessel, and keeps bleeding to a minimum (less blood is lost this way than through cutting the vessel).

You then repeat the process on the other testicle. No stitches are needed as the wound will heal quickly on its own. It is a good idea to treat the wound with an antiseptic (iodine or alcohol) before releasing the piglet. If you can keep the piglet on clean, dry bedding for 24 hours after castration, this will also reduce the chance of infection. Be sure to examine the piglet daily for the first 3 days following castration to examine the wound for any sign of infection. If the piglet continues to eat and remains active, these are good indications that it will be O.K.

## Castrating Older Pigs

You may upon occasion find it necessary to castrate a full grown boar before he is to be sold off or slaughtered. As you can imagine, castrating a full grown boar is no small task. It creates considerable trauma for the boar and the volunteer. If you have never practiced this before, I would not recommend you trying to learn how in front of your peers or with someone else's pig. Find someone who knows how to do this and then assist him or her. Castration of an animal this age is traumatic for the boar and if not done properly can cause death.

The illustrations that follow show two different methods of castration. The first shows a young piglet being castrated through the use of 2 incisions. The second method shows a 60-70 pound pig being castrated, but with only one incision being made. This one cut method is good in that there is only one wound to heal and reduced chances of infection. However, to remove both testicles through a single opening requires practice and this is not a practice that I would recommend to novices. Younger pigs can be castrated just as easily through two incisions and it is easier for the person who is still learning how.

## Recordkeeping and Field Notebook Guide for Swine

The sample records that have been included are designed to provide ideas about recordkeeping and important points and dates that you would want to keep track of. No matter how large or small your swine herd, recordkeeping is important as a management tool and can affect the profit of your operation. The design or format of these records is not important; you may find that given the size of your herd you can keep detailed records that are adequate for you on a large calendar. Some of the points included on these sample records are obviously not needed in all cases (such as the sow's pedigree). They are intended to provide one sample of how a recordkeeping system can be organized and to provide ideas on important points. Listed below are some of the points that I consider to be important and that should be included in your records and field notebooks. Remember that these are not feed consumption records (which should be kept separately) but are breeding and production records.

1. Breeding date of sow
2. Breed of the sow and mating boar
3. Identification of the breeding boar
4. Farrowing date of the sow
5. Number of piglets born (and how many of each sex)
6. Their birth weights
7. Number of piglets weaned and their weaning weights
8. Weaning date
9. Health and temperament observations of the sow
10. Number of piglets born dead
11. Number of functioning teats of the sow
12. Which of the litter were kept for future breeding stock and which were sold off or eaten.
13. Assign a number to each individual litter
14. Is it the first, second, third, etc. litter of the sow?
15. Complete health records: Dates and dosages of any vaccinations or medications
16. Date and cause of any death
17. Any findings from postmortem examinations
18. Any notes or findings on individual or overall herd health
19. Castration, iron shots, and clipping of needle teeth dates
20. Who was the pig sold to and for how much?

## FIELD NOTEBOOK OUTLINE - SWINE

1. Breeds present

2. Feeding system

    a) Locally available foods

    b) Commercial feeds (% protein, antibodies)

    c) Amount of commercial feed given

3. Breeding

    a) Preparation of sow before farrowing

    b) Farrowing date, number in litter, mortality, problems

    c) Care of piglets (dipping naval, clipping eyeteeth, I.D., castration, iron shots)

    d) Maintenance of piglets (feed, weaning weight, weaning date)

4. Health

    a) Deparasitation schedule, dates: with what products, against which parasites, how each medication is administered.

    b) Diseases/other problems if they appear

5. Housing -- description of what is available

6. Management Practices

    a) Animal distribution

    b) Type of operation (for meat, for breeding stock)

### Weighing of Pigs

If you find that you need to know the weight of a pig and there are no scales around on which to weigh the animal, there is another method for determining weight. The formula is shown below.

Heart Girth X Heart Girth X Length ÷ 400 = Estimated Weight in pounds

The length is the distance from the base of the tail to a point midway between the ears--with the pig's nose off the ground. The heart girth is taken just behind the front legs. You will need to use a tape measure that reads in inches--not centimeters. It is an accurate method for pigs weighing up to 400 pounds.

Illustration 2-2

## Litter Record

**Breed**________________ **Litter No.**________________ **(notch, tattoo)**

**Data on Dam:**

**Pedigree:**________________ **(name, reg. no., and ear notch)** { ____________ **(Sire)** ____________ **(Dam)**

**Birth date**________________ **(date and year)**

**Litter mate carcass data, if any:**

**No. carcasses**________; **Av. back fat**________ **(in.)**; **loin eye**________ **(sq. in.)**; **length**________ **(in.)**

**Sow's**____________ **(1st, 2nd, etc.)** **Litter.**

**Data on Sire:**

**Pedigree:**________________ **(name, reg. no., and ear notch)** { ____________ **(Sire)** ____________ **(Dam)**

**Birth date**________________

**Litter mate carcass data, if any:**

**No. carcasses**________; **Av. back fat**________ **(in.)**; **loin eye**________ **(sq. in.)**; **length**________ **(in.)**

**Date of birth**________________

**No. pigs born:**

**Alive**____________

**Dead**____________

**Mummies**____________

**Total**____________

**No. pigs weaned**____________

**Health Services:**

**Date cholera vaccinated**____________

**Date erysipelas vaccinated**____________

**Date wormed**____________

**Other, including iron pills or shots (list)**____________

________________________

________________________

Litter Record. (See next page for lower half of form.)

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Illustration 2-3

**Individual Pig Record**

| Pig's No. | Sex | No. Teats | Birth Wt. | Off Color Markings | Defects & Abnormalities | Weaning Wt. ________days (fill in) | Date Castrated | Date & Cause of Death | Disposal Date & To Whom | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
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Illustration 2-4

**Individual Sow Record**

Breed ______ Name and Registration No. ______

Date Farrowed ______ Identification ______ (ear notch, tattoo)

Bred by ______ (Name and address)

Sow's pedigree: ______ (Sire) { ______ / ______

______ (Dam) { ______ / ______

Record of litter of which the sow was a member:

No. in litter ______ No. of pigs weaned ______

Weaning wt. at ______ (fill in) days of age:

Her own wt. ______ Av. wt. of litter ______

Litter mate carcass record, if any:

No. carcasses ______; Av. back fat ______ (in.); loin eye ______ (sq. in.); length ______ (in.)

Number of teats ______

Individual Sow Record. (See next page for lower half of form.)

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## Illustration 2-5

### Production Record of Sow

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Litter No. | | | | | | | | |
| Sire | | | | | | | | |
| No. services | | | | | | | | |
| Farrowing data: | | | | | | | | |
| Date | | | | | | | | |
| Temperament of sow: (Gentle; nervous; cross) | | | | | | | | |
| No. pigs born: | | | | | | | | |
| Alive | | | | | | | | |
| Dead | | | | | | | | |
| Mummies | | | | | | | | |
| Total | | | | | | | | |
| Av. birth weight | | | | | | | | |
| No. functioning teats | | | | | | | | |
| Weaning data: | | | | | | | | |
| Age | | | | | | | | |
| No. Weaned | | | | | | | | |
| Av. weaning wt. | | | | | | | | |
| Offspring saved for breeding: | | | | | | | | |
| No. gilts | | | | | | | | |
| No. boars | | | | | | | | |

### DISPOSAL OF SOW

Date__________ Reasons__________

Sold to__________

(Name and address)

Price $__________

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## Credibility Techniques

Credibility techniques are management tools that volunteers can work with in their villages. They are designed to help gain the volunteer credibility in the eyes of his/her coworkers. Therefore, ideally, they are techniques that cost very little money, show immediate results, use local materials, can be easily repeated by local farmers, and increase production. Examples of some credibility techniques for swine are listed below. When reviewing these techniques in light of the aforementioned criteria, it is obvious that some are "better", or can be applied more easily, than others; however, over the course of a two-year service all of these may be useful.

1. Castration of young boars (2-3 weeks after farrowing)
2. Clipping of needle teeth
3. Dipping the umbilical cord/navel in iodine after farrowing
4. Wipe-off the sow's teats just before and after farrowing
5. Disinfect and sun dry pens
6. Use a farrowing crate
7. Use guard rails in the farrowing pen
8. Provide iron injections to newborn piglets
9. Add a calcium source to the ration
10. If the pigs are being fed a grain, add vitamin and mineral supplements to their feed.
11. Spray with malathion or sevin for mange and lice
12. Deworming
13. Heat source for piglets (at night or during cold days)
14. Vaccinations (hog cholera, brucellosis, rhinderpest)
15. Ad-lib water
16. Wiping off the piglets during farrowing
17. Postmortem examination of diseased animals
18. Feed at night during the hot season

## Swine Diseases and Parasites -- Treatment Procedures

For specific information on the treatment of parasites and diseases for swine refer to the specific disease or parasite in the disease and parasite section of the guidelines for swine.

## Swine Post Mortem Procedure

You should remember that there are several diseases of swine that are zoonotic. Refer to Disease section of the guidelines for swine to identify which diseases are transferrable to humans. If you are considering doing a post mortem examination of a pig that you think has one of these diseases, then you should use rubber gloves and a mask. Clean up well afterwards with plenty of soap and water and dispose of the carcass properly.

If the pig is not yet dead, you should kill it and then begin cutting under the rib cage on the right side. Remove the organs in the order listed below.

- Large Intestine
- Small Intestine
- Spleen
- Stomach
- Liver
- Kidneys
- A piece of a rib
- Esophagus, trachea, lungs, and heart should be removed together.

### Examination of Organs

The skin can be examined to find signs of hog cholera, mange, zinc deficiency, and any protein, mineral, and/or vitamin deficiencies.

Open the large intestine and examine the contents. Parasitic worms if present should be in the large intestine. Look also for any abnormal hemorrhaging, discoloration, twisting, or knotting.

Look in the small intestine for the same things as in the large intestine. Tape worms will often be wrapped around the small intestine.

An unhealthy stomach will have perforations, ulcerations, and/or hemorrhaging. Symptoms of hog cholera may be seen in the stomach. The connecting tissue between the stomach and the small intestine may house hookworms.

On the liver look for white spots (Ascarids), mottling, discoloration, abnormal shape and/or size of the lobes, abnormal bile color, or a whitish color (anemia). Cross cut the liver to look for any abscesses or color other than red.

An enlarged spleen is indicative of Erysipelas. Look also for any surface alterations, abscesses, nodules, or abnormal size or shape. If the spleen is diseased then the liver might be as well.

If the right kidney is slightly larger than the left there is no reason for alarm: it is normal. However, any abscesses, discolorations, or hemorrhaging are not normal.

In the rib any color other than white can indicate problems with calcium and phosphorus absorption or hog cholera. If the pig died of hog cholera then the symptoms at death should make it obvious. The rib bone should break with a clean, crisp snap. If it does not this can indicate a deficiency of other minerals due to a Ca/Ph imbalance.

Mottling or discoloration of the esophagus indicates a Vitamin A deficiency which can occur with improperly stored grains.

If the lungs have a purple discoloration this can indicate either Microplasma pneumonia or the presence of parasitic worms. If the lungs are full of hemorrhage or coagulated blood this is probably a result of the way the pig died. Calcified nodules can indicate TB, lung worms, or ascarids. It is a good idea to cut out a cross section of the lung for examination.

Hemorrhaging in the heart can be caused by hog cholera.

A striated cross-cut on the tongue indicates a vitamin E deficiency. If nodules are present they can be indicative of Foot and Mouth disease.

# SWINE DISEASES

Volunteers who work with swine projects (be it with farmers, crops schools, or clubs) should place more emphasis on disease prevention than treatment. Working to improve the diet of the herd, improving sanitation, and management practices are all good ways to prevent disease. Remember that prevention is generally less expensive than treatment and therefore, more profitable to the project. Consider the following points:

1. Morbidity disease decreases the productivity of swine (i.e. the feed to gain ratio drops) and usually is more damaging to a swine operation than mortality disease.
2. Reproductive diseases are often the most difficult to diagnose.
3. Disease diagnosis is often difficult for generalist volunteers. Many times there are no labs available to do diagnostic work.
4. There will probably not be veterinarians to assist in diagnosis or treatment of animals. In order to have a project that faces these limitations of resources and is still capable of being profitable it is important first to emphasize prevention of disease. Furthermore, the volunteer should be competent with post mortem procedures in order to be able to assist in diagnosis of disease(s) and parasite(s) through identification of clinical symptoms.

## The following herd management practices will help reduce disease

1. Close observation of the herd for abnormal or diseased behavior.
2. Keep precise feed consumption, breeding, and production records.
3. Maintain a regular vaccination and parasite control schedule for your herd against disease known to be in your area.
4. Quarantine all new stock for at least 30 days.
5. When buying new stock have them tested first for brucellosis.
6. If your pigs are penned then try to prevent contact with free-ranging pigs.
7. Lessen stress by providing shade - especially during the hot season.
8. Provide adequate water for drinking and clean the pen regularly.
9. If you have a disease outbreak then follow proper quarantine and clean up procedures.
10. Assist the sow during farrowing.

Finally, since pigs are common intermediate hosts for diseases and parasites that affect man (this transfer between species is called zoonoses) be careful with your own health. This is especially true if you have an outbreak of an undiagnosed disease in your herd.

## Reproductive Diseases

### 1. Brucellosis (Bang's disease)

This is a bacterial disease caused by 3 different (but very closely related) germs. It is widespread and can be found on all continents. It is important to control this disease because of the potential of economic loss to the project or farmer and because it is zoonotic and there is always a danger of human infection.

#### Symptoms

1. Abortions are common with sows.
2. Sterility, swollen joints, lameness, and swelling or atrophy of the testes and the prostate in males

#### Prevention

1. Strict sanitation.
2. Testing of animals for the disease and culling all those found to be be infected before the disease spreads.
3. Isolation of sow from herd during farrowing.
4. Insuring that all animals, feed, and water brought into contact with your herd are pathogen free.
5. Prevention by the use of vaccine (either heat-killed or modified live) have not been successful.

#### Treatment

1. No known medicinal agent is effective in the treatment of brucellosis. Culling and slaughter of infected animals seems to be the only known means of controlling the disease.

This is a morbidity disease that is zoonotic to humans. It produces a disease in humans known as either Malta Disease or Undulant Fever. More specific information on these diseases and their effects on humans is available in "Where There is No Doctor". Transmission to humans often occurs when we handle infected swine during slaughtering and farrowing. If you suspect the sow, then do not handle the fetuses, placenta, or any portion of the sexual reproductive tract. Pasteurizing milk (in the case of cows and goats) and thoroughly cooking the meat will kill brucellosis. The disease may be harbored indefinitely in the udder, sex glands, spleen, liver, kidneys, bloodstream, joints, and lymph nodes of the swine. Transmission from boar to sow is sexual.

### 2. Listeriosis (Circling Disease)

This disease results from the invasion of the central nervous system by a bacterium. The method of transmission is unknown, and there are no practical methods of treatment. It most commonly occurs following a sudden drop in temperature.

#### Prevention

1. Good sanitation.

2. Avoid stress through temperature changes.

3. There are no available vaccines.

#### Treatment

1. There is no known treatment.

#### Symptoms

1. Depression, staggering, circling, and awkward movements. Continual circling in one direction.

This disease is more common in ruminants than swine but can be transmitted to man as well. It is a mortality disease with death often approaching 100%.

### 3. Leptospirosis

This is a bacterial disease that affects baby pigs causing them to either abort, be born dead, or be severely weakened at birth. Contaminated stock that survive birth will remain weakened and unthrifty with this morbidity disease. It is zoonotic. Humans contract it through skin abrasion when in contact with infected animals, swimming in contaminated water, eating raw meat, or drinking raw milk.

#### Prevention

1. Blood testing of all new stock and quarantine or isolation for 1 month before joining the herd.

2. Vaccinate annually.

#### Treatment

1. Antibiotics such as tetracycline. If left untreated swine can be carriers for up to one year.

### Symptoms

1. Anorexia, depression, loss of weight.

2. High fever for 2-3 days, blood in urine.
   If you should have an outbreak of this disease you should quarantine the herd and clean and disinfect their quarters.

## 4. Foot & Mouth Disease

This is a highly contagious disease of swine constantly present in Africa, South America, and Asia. It is caused by a virus (actually by 7 different and distinct viruses) and man, though mildly susceptible, is rarely infected. It is a morbidity disease with few losses to death but the productivity of infected swine is so reduced that it can cause great economic loss.

### Prevention

1. Slaughter and quarantine of infected stock.

2. Vaccination (3-4 times annually).

### Treatment

1. The FMD virus is quickly destroyed by lye, however, no attempt is made to treat animals that are known to be infected.

### Symptoms

1. Moderate fever.

2. Blisters form on the mucous membranes of the mouth, tongue, lips, palate, cheeks, skin around the feet, teats, and snout.

3. The virus is present in the fluid and covering of the blisters, in the blood, meat, milk, saliva, urine, and other secretions of the infected animal. The virus may be passed in the feces and urine.

The normal rectal temperature of swine is 102.6.
The normal pulse rate is 60-80 per minute.
The normal breathing rate is 8-18 per minute.

## Mortality Diseases

## 1. Hog Cholera

This is a viral disease endemic to South America, Africa, and Asia. It is highly contagious and acute. It is not zoonotic.

### Prevention

1. Quarantine of infected stock followed by slaughter and either burning or burial of the carcasses.

2. Vaccination by either a modified live virus (MLV or attenuated) or an inactivated vaccine. The MLV provides more long lasting immunity.

### Symptoms

1. Sudden onset of fever (after a one week incubation period of the virus), loss of appetite, and weakness.

2. A wobbly, scissor like gait.

3. The belly may turn a purplish red.

4. Chilling, coughing, alternating diarrhea and constipation.

### Treatment

1. Slaughter and disposal of infected stock.

This disease is spread by pig-to-pig contact and by feeding uncooked pork. After an outbreak, pens should be disinfected and left vacant for at least 2 weeks.

## 2. African Swine Fever

A highly contagious, usually fatal, viral disease of pigs that resembles hog cholera. Although it is most common in Africa it has been diagnosed in The Dominican Republic, Haiti, and Brazil. This disease is not zoonotic. In Africa outbreaks of this disease occur when domestic swine are brought into contact with wart hogs, bush pigs, or forest hogs through vectors such as ticks.

### Prevention

1. Regular treatment for ticks (especially if your project is in an area known for this disease).

2. Prevent contact with wild hogs or other potential vectors of this disease. There is no vaccine for this disease.

### Symptoms

1. The symptoms are nearly identical to hog cholera. Clear diagnosis is only possible through lab test. For lab testing, samples should be taken from the blood or spleen 2-3 days after the onset of fever.

### Treatment

1. There is no treatment. Strict quarantine and slaughter. Death occurs within 4 to 7 days after the onset of fever. Mortality often reaches 100%. If there are survivors they are usually carriers for life although the virus is not continually present in the excretions.

## 3. Hypoglycemia

This is a common cause of death for piglets less than one week of age. If a piglet does not receive adequate colostrum or milk, then low blood sugar leads to this disease. Nutritional deficiencies of the sow that limit milk production can cause this. Piglets are prone to this disease because they have very limited energy reserves and are very susceptible to low temperatures, drafts, and wet environments. Commonly if this disease is present it will effect most of the piglets in the litter. Furthermore, the weakening produced by this disease leaves the piglet very susceptible to other piglets' diseases. This disease is not zoonotic.

### Prevention

1. Keep the sow healthy and on a good ration during gestation.
2. Keep the piglets warm and dry after farrowing. (73-95°F)
3. Make sure all piglets receive colostrum by nursing several times during the first 24 hours following birth.

### Treatment

1. Provide a heat source and dry bedding for the piglets.
2. 15 ml. of 5% glucose given by intraperitoneal injection to piglets (response to this shot should occur in 5-10 minutes).
3. Administer oxytocin to the sow (check the label for dosage by I.M. injection to the shoulder or hip).
4. If the sow, after being given the oxytocin injection, still fails to produce milk then use a solution of 30 to 50 ml. of 5% dextrose or powdered milk mixed 50-50 with water force fed to piglet. Do not add sugar to this solution. Give 300-500 ml. daily for 4 days and then increase the dosage to 1,000 ml. daily for 10 more days.

### Symptoms

1. Lack of milk or colostrum being produced by the sow.
2. More piglets than teats.

3. Piglets will not suck vigorously. They may wander with a faltering gait and cry weakly. Poor muscle tone, hypothermia, and cold clammy skin are shortly followed (12 to 24 hours) by coma and death.

## 4. TGE - Transmissable Gastroenteritis

This is a rapidly spreading viral disease. It is not zoonotic. It is transmitted through feces and by airborne infection. Pig may shed the virus up to 8 weeks after infection. The virus is killed by sunlight and heat.

### Prevention

1. By planned infection of gestating sows with a virulent virus which produces effective immunity in the sow that is passed through the colostrum to the piglets. This vaccine is to be used only when the sow will be exposed at farrowing time to this disease.

2. Quarantine or isolation at farrowing time of disease free stock is recommended.

### Treatment

1. No effective treatment is known, but good feeding and management will help. High level antibiotic feed supplements or sulfa drugs may minimize secondary bacterial complications.

### Symptoms

1. It is characterized by marked scouring in all cases, by vomiting in some cases, and by high mortality losses in pigs less than seven to ten days of age. Usually, the body temperature remains normal. It affects swine of all ages, but the loss in older swine is low.

## 5. Anthrax (Splenic Fever or Charbon)

This disease occurs worldwide with repeated outbreaks in parts of Africa, Asia, and South America. It is caused by a gram positive bacterium known as baccilus anthracis. It is a zoonotic disease that effects all warm blooded animals (including man) but is most common in cattle. It often occurs in grazing animals following a flood of their pasture land. This bacterium forms spores which are resistant to heat, low temperature, chemical disinfectants, and drying. They may persist for a long period in dry projects or soil. This disease can be spread through contact with infected animals or by mechanical vectors such as flies.

### Prevention

1. It can be prevented by vaccination. In the so-called anthrax regions, vaccination should be performed well

in advance of the time when the disease normally makes its appearance. There are many different types of biologics (serums, bacterins, and vaccines) used for anthrax vaccinations. You should check to see what is available to you. This disease commonly occurs at the beginning of the rainy season.

2. Quarantine of infected animals may prevent other animals from contracting this disease.

### Treatment

1. Since anthrax is a highly fatal disease, early treatment and rigid control procedures are essential. When an outbreak occurs it is best to use antibiotics for the sick and immunize all "apparently" well animals in the infected herd and surrounding community. Oxytetracycaline and penicillin are the best antibiotics to use for its control.

2. Dead animals should be cremated or buried deep. Sick animals should be isolated away from infected areas. Manure and bedding should be burnt. All pens, barns, and contaminated equipment should be disinfected. People should avoid contact with affected animals and dead animals should not be exposed to scavengers. A rigidly enforced quarantine should be in effect.

### Symptoms

1. Rigor mortis is frequently absent or incomplete.

2. Dark blood may ooze from the nostrils or anus.

3. There is a swelling of the throat which leads to death by suffocation and blood poisoning.

4. Other signs are: high temperature, loss of appetite, muscular weakness, depression, and the passage of blood stained feces.

## 6. Edema

This is an acute, usually fatal disease of young pigs (6 to 16 weeks of age). It is usually associated with some management changes such as weaning. It commonly occurs 1 to 2 weeks after weaning. It is sporadic but most affected pigs die. It is caused by the rapid proliferation of E. coli in the upper small intestine. It is not zoonotic.

### Prevention

1. Avoid sudden changes in management.

2. Provide antibiotics to weaner pigs during the weaning.

**Treatment**

1. 60 grams of magnesium sulfate as a drench is the most common form of treatment, however, any treatment is largely impractical.

**Symptoms**

1. It usually strikes the largest, most thrifty, and rapid-growing pigs.
2. High temperature and swollen eye lids.
3. Constipation, inability to eat, and staggering gait.
4. Swelling of the intestines and stomach.
5. Fits and convulsions followed by complete paralysis just prior to death.

### 7. Scours

This is an acute, and often highly fatal, disease of young (suckling) piglets. The E. coli and TGE viruses are often the cause of this disease. Usually more than one organism is present. Maternal immunity can be transferred to piglets through the colostrum. It often effects more than one or two of the piglets in a litter. Sows are not affected.

**Prevention**

1. Good management practices such as strict sanitation, use of good disinfectant, and not overcrowding farrowing sows help to prevent this.
2. Avoid the following conditions: poor sanitation, drafts, dust, dampness, chilling, insufficient bedding, iron anemia, and poor quality feed rations.

**Treatment**

1. Ampicillin, IV or IM, (4.5 to 9 mg./lb. daily in divided doses to the piglets).
2. Oxytetracycline, IV or IM, (5 mg./lb. of body weight daily for 3 days).

**Symptoms**

1. A creamy yellow or grayish green watery feces. Affected piglets are dull, cold, fail to eat, and dehydrate quickly.
2. Post mortem symptoms include an emaciated carcass and the contents of the intestine are very fluid.

## 8. Pneumonia

This is a widespread disease of all animals, including man and swine. It can be zoonotic. If it is untreated 50 to 75% of affected animals die. It can be caused by a virus.

### Prevention

1. Preventive measures include providing good hygenic surroundings and practicing good, sound husbandry.

### Treatment

1. Sick animals should be segregated in quiet clean quarters away from drafts, and given easily digested nutritious feeds. Antibiotics and sulfas are used in the treatment.

   - Causes may include: (1) many microorganisms, (2) inhalation of water or medicines given by untrained persons as a drench, (3) viruses, and (4) lungworms.

### Symptoms

1. Inflammation of the lungs.

2. Chilling, fever, quick & shallow respiration.

3. Coughing and difficulty breathing.

4. Discharge from the nostrils and eyes.

## 9. Rabies (Hydrophobia)

This is an acute infectious disease of all warm-blooded animals and man. It is caused by a virus. It is transmitted from animal to animal by means of a bite introducing the virus-bearing saliva. It is difficult to control because of the reservoir of infection in wild animals and bats. For its effect on humans, refer to page 181 of Where There is No Doctor. It is not a common disease of swine.

### Prevention

1. It is best to prevent any contact between your swine and any other wild animals - especially predators. There is a vaccine for dogs.

### Treatment

1. There is no practical treatment of this disease for swine.

### Symptoms

1. Irritability, aimless wandering, hoarse grunting, and gnawing or rubbing the bitten spot.
2. Sudden jumping if disturbed, finally paralysis and death.

## 10. Tetanus (Lockjaw)

Tetanus is a wound infection disease that attacks the nervous system of horses and man, although it does occur in swine, cattle, sheep, and goats. The disease is spread worldwide. The incubation period varies from one to several weeks, but usually averages 10 to 14 days. The disease is caused by an exceedingly powerful toxin produced by the tetanus organism (clostridium oxygen). This organism is an anaerobe (lives in the absence of oxygen) which forms the most hardy spores known. Swine can acquire the infection through castration, open wounds, or umbilical cords that are cut with a dirty instrument. It produces an 80% mortality rate.

### Prevention

1. Good managment and sanitation practices.
2. Reducing the probability of wounds along with proper treatment.
3. Vaccines have been developed for tetanus, but will probably not be available to volunteers in the field.

### Treatment

1. Use oxidizing disinfectants (such as iodine and chlorine) on wounds - especially deep or puncture wounds.
2. Treatment of this disease (in its advanced stages) is impractical.

### Symptoms

1. The first symptom is a stiffness about the head.
2. The pig will chew slowly and weakly and swallow awkwardly.
3. Violent spasms or contractions of muscles.
4. The pig will attempt to remain standing.

## 11. Tuberculosis (T.B.)

Tuberculosis is a chronic infectious disease of man and animals. It is characterized by the development of nodules (tubercules) that may calcify or turn into abscesses. The disease spreads very slowly, and affects mainly the lymph nodes. There are 3 types of tubercule bacilli--the human, the bovine, and the avian (bird) types. Swine are subject to infection by all 3 types. Infection usually occurs in swine when they eat infected material. The lesions in swine occur in the lymph nodes and intestinal tract. Swine react most strongly to the bovine bacilli. However, the majority of swine T.B. cases are due to the avian bacilli.

### Prevention

1. Although it is admittedly difficult, especially in free range environments, if there is an outbreak of tuberculosis in other animals (especially chickens) care should be taken to keep the pigs from eating any portion of an infected animal.

2. The intradermic method of tuberculin testing is used for swine. It consists of the injection of tuberculin into the dermis, usually on the ear or back. Upon injection into an infected animal, tuberculin will set up in the body a reaction characterized by a swelling at the site of the injection.

3. To control T.B. in swine follow these procedures: (a) dispose of tubercular swine, cattle, and poultry, (b) apply strict sanitation, and c) rotate pens and pastures.

### Treatment

1. There is no effective treatment.

### Symptoms

1. Many times an infected animal will show no outward physical signs of the disease. There may be a gradual loss of weight and condition and swelling of joints, especially in older animals. If the respiratory system is affected, there may be a chronic cough and labored breathing.

## Morbidity Diseases

### 1. Mycoplasma Pneumonia

A chronic, infectious respiratory disease that occurs worldwide. It is a major disease of swine that can severely limit feed conversion and therefore profit. This disease is caused by the Mycoplasma organism. This particular strain of pneumonia is not zoonotic. It has been shown that the feed efficiency of affected pigs may be lowered by 25%. It is transmitted by contact (direct) between infected and normal swine. Pigs of all ages are susceptible, but between the ages of 14 to 26 weeks they are most prone to secondary lung complications.

### Prevention

1. Avoid the purchase of animals from infected herds (quarantine new stock until you are sure of their health).
2. Prevent contact between your herd and free-ranging pigs.

### Treatment

1. Treatments can help control bacterial complications. Tylosin, tetracycline, and streptomycin are used to treat this.
2. Treat for lungworms regularly (if they exist in your area) because they are a precursor of this disease since they are a common vector.

### Symptoms

1. Coughing is the most obvious symptom.
2. Diarrhea, a slight fever, and a drop in weight gain are also symptoms. A post-mortem exam would show lesions on the lungs.

Mortality losses are quite low (1 to 4%). It causes stunting of growth and a delay in reaching market weight. Good husbandry practices and reducing the stress on your herd are the best preventatives.

## 2. MMA Complex (Mastitis-Metritis-Agalactia Complex)

This is a disease of sows and gilts characterized by an inflammation of the mammary glands (mastitis), of the uterus (metritis), and/or a failure to secrete milk (agalactia). The mortality losses are low in sows, but high in the baby pigs. It is not zoonotic. It is more common in sows than gilts. How the disease is spread remains unclear. The organisms thought to cause the MMA syndrome include E. coli and Mycoplasma hyogenatalium. However, the disease is complex, and the actual cause is unknown.

### Prevention

1. Sound management practices, good sanitation, etc.
2. Avoid overfatness and constipation of sows. 6-10% molasses in the ration will control constipation.
3. Minimize stress. Avoid deficiencies of phosphorus, calcium, vitamin E, and selenium.
4. Provide a well balanced and bulky gestation diet. Increase the feed after farrowing gradually.

**Treatment**

1. Antibiotics to eliminate infections (penicillin). Oxytocin to stimulate the sow's milk production. If this fails then the piglets should be hand-fed or placed with another sow.

2. Nitrofuran or an oral antibiotic can be used if the piglets develop diarrhea.

**Symptoms**

1. The first signs of the disease usually appear within 3 days after farrowing. A whitish or yellowish discharge of pus appears from the vagina of the sow and the temperature may rise to 103 to 106°F. The sow goes off feed, stops milking, and the piglets often develop diarrhea. If the disease is not treated the piglets may starve to death.

2. The sow is not significantly affected and will recover.

## 3. Erysipelas

This is an acute or chronic infectious disease of growing swine. There are fewer instances of it in mature breeding stock and it is fairly common in many of the swine-raising areas of the world. It is caused by a bacterium and is zoonotic. This disease in man is called erysipeloid. This disease takes one of 3 forms: the acute, the subacute, and the chronic. The acute form causes death, but the chronic (milder) form is more damaging to the profit of the farmer. If the disease is endemic then young pigs will receive maternal antibodies through the colostrum and develop their own active immunity later. This organism may be shed by infected animals. Eating of infected feeds will lead to infection (this is how the disease is commonly spread).

**Prevention**

1. Vaccination by either killed bacteria or live strains of low virulence. Vaccination raises the level of immunity, but does not provide complete protection. Breeding stock should be revaccinated yearly. If there is an outbreak of the acute form an antiserum may be used on in-contact pigs that are not yet affected. The bacterium is able to reproduce either in the soil or in an infected animal making control very difficult.

**Treatment**

1. Penicillin is the most common antibiotic to use for this disease.

Symptoms

1. The acute form: Similar to the symptoms of hog cholera (high fever and purplish patches on the belly).

2. The subacute form: (Diamond-skin form) skin lesions will last from one to two weeks. The typical lesions are reddish rectangular plaques in the skin. Dry gangrene may affect the ears and tail.

3. The chronic form: Localizes in the ear and joints. The knees and hocks often become enlarged and stiff. These pigs are usually unthrifty.

## 4. Enteritis

This is a general term referring to several enteritic diseases, all of which produce an inflammation of the intestines. E. coli or Salmonells cholerae-suis may be among the common causes. Most outbreaks affect healthy, recently weaned pigs. Older animals seem less affected. It is often caused by the stresses of overcrowding, unusually high or low temperatures, and a sudden change in the feed ration. It is not zoonotic. Internal parasites and a deficiency of some B-complex vitamins may also cause enteritis.

Prevention

1. Good sanitation and management practices.

2. Oral vaccination using killed E. coli antigens in the feed rations of weaner hogs may help as well.

Treatment

1. Limit the feed immediately and then restore it gradually over several days.

2. All affected pigs should be treated with one of the following mixed in their drinking water: neomycin, streptomycin, chloretetracyline, tetracycline, oxytetracycline, ampicillin, or nitrofurazone.

Symptoms

1. Depression, anorexia, slight fever, dehydration, and a brownish or grayish diarrhea.

2. Postmortem findings include: dehydration, a stomach filled with feed, and reddening of the small intestinal wall.

## 5. Influenza (Flu)

This is an acute, highly contagious respiratory disease. It is fairly common in Kenya. It is spread as an airborne infection within a herd, but not from herd to herd. Mortality losses are quite low and the disease only lasts 3 to 7 days. It appears suddenly, and in most cases all pigs that are infected show symptoms at the same time. This disease resembles the influenza of man, but is spread by a different virus and is not zoonotic. This disease is produced by a combination of a bacterium and a virus. The bacterium alone cannot cause disease, but is able to exist in a recovered pig for an extended period. The virus can cause a mild infection alone, but cannot survive in a healthy animal. Instead, the virus is found in the lungworm of the pig. The earthworm, however, serves as an intermediate host for the lungworm. That makes the life history as follows: The adult lungworm lays its eggs (containing the virus) in the lung of the infected pig, from which the eggs are coughed up, swallowed, and eliminated in the feces. Here the eggs hatch into larvae almost immediately. These larvae must then pass into (be eaten by) the earthworm before becoming infective. The pig then eats the earthworm that contains the lungworm larvae, which may in turn harbor the virus. These larvae then pass into the digestive tract, enter the lymph system, and migrate to the lungs. Here in the presence of the bacterium, the disease starts.

### Prevention

1. Use dry and clean pens and rotate pastures to break up the life cycle of the lungworm.

### Treatment

1. Antibiotics or sulfa drugs given by injection or through the drinking water to reduce the chance of secondary infections.
2. Attempt to reduce any poor management practices that create stress on the herd.

### Symptoms

1. Following a one week incubation period the disease will appear suddenly. High fever, loss of appetite, a cough, and discharge from nose and eyes are seen. The hogs may sit up like dogs in order to breathe easier.

Table 2-8
Disinfectant Guide

## HANDY DISINFECTANT GUIDE

(Chemical agents should not be relied upon to destroy spores; controlled and prolonged heat is required to kill spores.)

| Kind of Disinfectant | Usefulness | Strength | Limitations and Comments |
|---|---|---|---|
| **Alcohol** | Effective against the less resistant disease germs provided there is adequate exposure. | 70 percent alcohol—the content usually found in "rubbing" alcohol. | Limited application. Not recommended for general use. Often used as a local antiseptic in obtaining blood samples or making hypodermic injections. Not reliable for sterilization of instruments. |
| **Bichloride of Mercury** (mercuric chloride; corrosive sublimate) | Destroys less resistant bacteria under favorable conditions. Tends to prevent growth rather than actually destroy bacteria. Organic mercurials, sometimes used as local antiseptics, are less poisonous and more reliable. | Tablets used in a dilution of 1 to 1,000. | Unreliable as a germ killer in the presence of organic matter. Also, cattle are especially susceptible to mercury poisoning. For farm disinfection, bichloride of mercury is inferior to synthetic phenols, lye, saponified cresols, and the new cationic bactericides. |
| **Boric acid**[1] | As wash for eyes, and other sensitive parts of the body. | 1 oz. in 1 pt. water (about 6% solution). | It is a weak antiseptic. It may cause harm to the nervous system if absorbed into the body in large amounts. For this and other reasons, antibiotic solutions and saline solutions are fast replacing it. |
| **Cationic bactericides** (many commercial products available, including QAC, i.e., quarternary ammonium compounds) | Primarily detergents but some are actively bactericidal. Often used in sanitizing dairy or other equipment and utensils. Use only as recommended by a sanitarian. | Concentration varies with different products and under different conditions. Follow authoritative recommendations. | They have only a slight toxicity and are non-irritant and odorless. They are neutralized by soap, anionic detergents and even by mineral content of some waters. Superior to chlorine compounds in the presence of organic matter. They are not effective against T.B. organisms and spores. |
| **Cresols** (many commercial products available) | A generally reliable class of disinfectant. Effective against brucellosis, shipping fever, swine erysipelas, and tuberculosis. | 4 oz. per gal.; or according to the directions found on the container. | Cannot be used where odor may be absorbed, and, therefore, not suited for use around milk and meat. |
| **Heat** (by steam, hot water, burning, or boiling) | In the burning of rubbish or articles of little value, and in disposing of infected body discharges. The steam "Jenney" is effective for disinfection if properly employed—particularly if used in conjunction with a phenolic germicide. | 10 min. exposure to boiling water is usually sufficient. | Exposure to boiling water will destroy all ordinary disease germs, but sometimes fails to kill the spores of such diseases as anthrax and tetanus. Moist heat is preferred to dry heat, and steam under pressure is the most effective. Heat may be impractical or too expensive. |
| **Hypochlorites** (chlorine compounds) | For deodorizing manure, sewers, drains, and for disinfecting milk cans and bottles and around dairy barns. | 200 parts available chlorine per million of water. Unstable; replace solution frequently as recommended. | Excellent for disinfection, but with following limitations: Not effective against the T.B. organism and spores. Its effectiveness is greatly reduced in presence of organic matter, such as milk, even in small quantities. Hypochlorites deteriorate rapidly when exposed to air. |
| **Iodine**[1] | Extensively used as skin disinfectant, for minor cuts and bruises. | Generally used as tincture of iodine 2% or 7%. | Never cover with a bandage. Clean skin before applying iodine. |

Footnote on last page of table.

(Continued)

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Table 2-8
Disinfectant Guide
Page 2

| Kind of Disinfectant | Usefulness | Strength | Limitations and Comments |
|---|---|---|---|
| **Iodophor** (iodine complexed with a detergent which releases free iodine at a controlled rate) | For disinfecting milk cans and bottles around dairy barns and for area disinfection where large quantities of organic soil are not present. | 75 parts available iodine per million is minimum under ideal circumstances. 150 ppm is recommended for most practical uses. Unstable — replace solution frequently. | An excellent disinfectant but with the following practical limitations: Germicidal agent rapidly consumed by organic matter necessitating frequent replacement. Functions best in a highly acid range. Solution strength must be increased to get necessary available iodine when mixture is made with alkaline water. Iodine slowly volatilizes from solution. Considerable control should be exercised. |
| **Lime** (quick-lime; burnt lime; calcium oxide) | As a deodorant when sprinkled on manure and animal discharges; or as a disinfectant when sprinkled on the floor or used as a newly made "milk of lime" or as a whitewash. | Use as a dust; as "milk of lime"; or as a whitewash but use fresh. | Not effective against organism of T.B. and the spore formers. Wear goggles when adding water to quicklime. |
| **Lye** (sodium hydroxide or caustic soda) | On concrete floors; in milk houses because there is no odor; against microorganisms of brucellosis and the viruses of foot-and-mouth disease, hog cholera, and vesicular exanthema. In strong solution (5%) effective against anthrax and blackleg. | 1 can (13 oz.) to 12 to 15 gals. water. To prepare a 5% solution, add 5 (13 oz.) cans to 10 gals. water. | Damages fabrics, aluminum, and painted surfaces. Be careful, for it will burn the hands and face. Not effective against organism of T.B., or Johne's disease, or strangles, or most spores. When used in hog houses, lye should be mixed with hot water, as the heat of the water will destroy the worm eggs. *Diluted vinegar can be used to neutralize lye.* |
| **Phenolic germicides, synthetic** (those containing odorless nontoxic phenols such as orthophenyl phenol or orthobenzyl parachlorophenol) | A very reliable class of disinfectants effective against all disease-producing fungi and bacteria including the T.B. organism. | Varies with different formulations; follow directions on manufacturer's label. | Excellent for disinfection. They are not inactivated by soap, anionic detergents, hard water or organic matter. They are effective against all bacteria and fungi including the T.B. organism but not the spores of anthrax and tetanus. |
| **Sal soda** | It may be used in place of lye against foot-and-mouth disease and vesicular exanthema. | 10½% solution (13½ oz. to 1 gal. water). | |
| **Soap** | Its power to kill germs is very limited. Greatest usefulness is in cleansing and dissolving coatings from various surfaces, including the skin, prior to application of a good disinfectant. | As commercially prepared. | Although indispensable for sanitizing surfaces, soaps should not be used as disinfectants. They are not regularly effective; staphylococci and the organisms which cause diarrheal diseases are resistant. |
| **Soda ash** (or sodium carbonate) | It may be used in place of lye against foot-and-mouth disease and vesicular exanthema. | 5% solution (1 lb. to 3 gals. water). Most effective in hot solution. | Commonly used as a cleansing agent, but has disinfectant properties, especially when used as a hot solution. |

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[1] Sometimes loosely classed as a disinfectant but actually an antiseptic and practically useful only on living tissue.

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# SWINE PARASITES

Pigs are susceptible to many different internal and external parasites. You can be sure that in a free-ranging environment where the pigs eat feces and vegetable waste they will be heavily infested with parasites. In attempting to improve production one must rid the pigs of parasites or they will not be able to utilize the feed efficiently. Feed is always too expensive to give to parasites. Treatment for parasites is expensive, potentially harmful to the pig, and does not prevent reinfection. Prevention and control of parasites by breaking their life cycle is far more important than treatment. With both internal and external parasites it is important for you to know the various life stages and habits so that you can plan to disrupt their life cycles and destroy them. Pigs are also the intermediate host for many parasites that affect man. Therefore, eliminating parasites in swine will serve to eliminate them from man as well. The information that follows on different internal and external parasites should help you in your plans to break parasite life cycles by giving you an understanding of how each parasite develops.

## Internal Parasites

### 1. Ascarids (Roundworms)

This is a very common parasite in swine worldwide. It can severely damage the health and productivity of a pig. Furthermore, it is a parasite that (through poor sanitation) is often passed from swine to humans. Severe infestations of roundworms can cause death in young pigs. Lesser infections can stunt growth.

#### Life Cycle

The adult worm is usually yellowish or pinkish in color, 8 to 12 inches long, and almost the size of a lead pencil.

1. The female worms lay eggs in the small intestines which are passed in the feces. These eggs are very resistant to chemical agents.

2. A small larva develops in the egg and remains there until the egg is swallowed by the pig (or human) along with contaminated feed or water. Then it emerges from its shell, bores through the wall of the intestine, and enters the bloodstream. It passes through the liver (producing white spots on the liver) and is carried to the lungs.

3. In the lungs, the larvae break out of the capillaries, enter the windpipe, and migrate to the throat. While in the throat, they are swallowed and lodge in the intestines where they develop into sexually mature worms, thus completing their life cycle.

### Prevention

1. The best way to prevent roundworms is by disrupting their life cycle through removing pigs from potential contact with the roundworm. This is impossible in free-range environments. If the pigs are penned or on pasture then rotation of the pens or pastures to prevent large build-ups in the roundworm population can be practiced. The first step to control of roundworms is confining the pigs and then managing their pens or pastures. If the pigs are already penned then practice these 3 steps (if they are appropriate to your village and resources).

    a. Disinfect the farrowing quarters.

    b. Wash sow before moving into farrowing quarters.

    c. Keep the sow and litter on "clean" pasture until they are at least four months old.

### Symptoms

1. The adult worms do not produce obvious symptoms that are detectable.

2. The larvae can cause serious lesions of the liver and lungs. General unthriftiness and loss of weight are often seen. Coughing and a "thumpy" breathing may occur also.

### Treatment

1. Dichlorvos (Atgard) Use 0.0384% in the feed. For swine of less than 70 pounds limit the treatment to two days. For boars and open or bred gilts divide the dose in half and feed for 2 days.

2. Piperazine (Piperazine monohycrochloride -17 grams per 100 ml.) Use 1 fluid ounce to 1 gallon of drinking water per 100 pounds of body weight. Caution: There are other forms of Piperazine of varying strengths and dosages vary.

3. Thiabendazole is mixed at varying strengths by different manufacturers. Check the label for dosage.

## 2. Coccidiosis

This disease is produced by protozoan organisms called coccidia that live in the cells of the intestinal lining. The coccidia that affect swine are specific to swine and do not infect other animals. Coccidia are endemic worldwide. They rarely cause death, but do lower weight gains.

### Life Cycle

Infected swine can pass thousands of coccidia (oocysts) daily in their feces. With favorable temperature and moisture, these oocysts sporulate to maturity in 3-5 days producing 8 infective sporozites. The oocyst is then swallowed by the pig in contaminated feed or water. In the pig's intestines, the outer membrane of the oocyst, acted on by the digestive juices, ruptures and liberates the 8 sporozites within. Each sporozite then penetrates and destroys an epithelial cell. While destroying the cell the coccidia undergoes sexual multiplication and fertilization with the formation of new oocysts. The new oocysts are then passed in the feces to later reinfect other pigs.

### Prevention

1. Coccidia thrive in wet and filthy conditions and are resistant to freezing and ordinary disinfectants.

2. These are impossible to control in a free-ranging environment. Only when you can control the quality of the feed and water can you eliminate coccidia. Oocysts are destroyed by sunlight and drying.

### Symptoms

1. Minor infections are difficult to detect with a lab examination of the feces. Reduced weight gain may be your only symptom.

2. Severe infections may produce diarrhea (may or may not be bloody) due to damage to the intestinal wall. Pigs 1 to 3 months old are most strongly affected.

### Treatment

If the pigs are not exposed to continual reinfection then the infection will last only a week or so before subsiding. Enteric sulfonamides such as sulfamethazine or sulfaquinoxaline are commonly used.

a. Sulfamethazine: Orally or IV, 100 mg./lb. of body weight the first day and then 50 mg./lb. daily for 3 to 4 days.

b. Sulfaquinoxaline: 6 mg./lb. of body weight orally, daily for 3-5 days.

Always read the label for recommended dosages as well.

## 3. Kidney Worm

The kidney worm is found worldwide and is second only to roundworms in the damage inflicted on swine. They are especially a problem in warm and moist climates. It is a thick-bodied black and white worm that may reach 2 inches in length when fully grown. It has an adverse affect on swine growth, but is not transferrable to humans. It can infect cattle that are grazing with swine.

### Life Cycle

Adult kidney worms may be found around the kidneys and in cysts in the ureter (tubes leading from the kidneys to the bladder). The mature female worms lay many eggs that are discharged with the urine. It has been estimated that as many as one million eggs may be passed in the urine of a moderately infected hog in one day. When eggs fall on moist, shaded soil, a tiny larva hatches from each egg in 1 to 2 days (depending on temperature). In another 3 to 5 days, the larva develops into the infective stage. Hogs then obtain kidney worms by swallowing the infective larvae as they root and forage. Kidney worm larvae can also enter the bodies of pigs through the skin if there is an open wound, but this is not a common source of the infection. Once inside the hog, they enter the bloodstream and migrate to the liver where they remain for 2-3 months causing extensive damage. They then enter the abdominal cavity and pass through the lungs eventually reaching the kidneys. 12 to 14 months after the larvae enter the pig, the adult female kidney worms begin to produce eggs, thus completing the life cycle.

### Prevention

1. Rotation of pastures, sanitation, and good management practices are one type of prevention that is not always possible in low level management (free-ranging) situations.

2. In areas where the kidney worms are a major problem (such as the south of the U.S.) farmers practice the "gilt-only method". With this method, gilts are bred only once; then, after farrowing and weaning off their first litter, thay are sent to slaughter before mature kidney worms develop. This system is based on the fact that it may take the kidney worm as long as a year to reach the egg-laying stage.

### Symptoms

There are no symptoms of this worm that are indicative solely of a kidney worm infection. Pus may appear in the urine and growth rates will decline. Positive diagnosis can only be made through lab tests of samples of the urine.

### Treatment

Feeding a concentration of 0.185 of thiabendazole in the ration for 14 days can prevent migration of kidney worm larvae. There is no treatment yet that will eliminate the adult worm.

## 4. Lungworms

This is a fairly common parasite of swine that is endemic worldwide. They are not transferrable to humans. There are 3 species that are common in hogs yet all 3 are threadlike in diameter, 1 to 1 1/2 inches in length, and white or brownish in color. They are found in the bronchi, or air passages, of the lungs. They are more common in warm and moist climates. Besides reducing the rate of growth, there is evidence that they are involved in the spreading of swine flu and cholera.

### Life Cycle

Female lungworms produce large numbers of thick-shelled eggs, each containing a larva. The eggs are coughed up, swallowed, and eliminated in the feces. Earthworms, the intermediate host, feed on the feces, then swallow the eggs, which hatch in the earthworms' intestines. The larva then develops within the earthworm for 3-4 weeks, after which it is capable of producing an infection. Infection of the pig results from the swallowing of the earthworm while rooting and foraging for food in manure piles, trash, and in moist feces-contaminated soil. After being eaten by the pig, the lungworm larvae leave the earthworm and migrate through the lymphatic and blood circulatory systems to the lungs. They remain in the lungs and begin to produce 1-1/2 months later, thus completing the life cycle.

### Prevention

The only means of prevention is preventing hogs from foraging or rooting for food in soil that contains earthworms.

### Symptoms

Positive diagnosis can only be made by examination of the feces in a lab or through post-mortem examination. Infected hogs will have with threadlike worms in the air tubes of the lungs (revealed easily in a cross-section of lung). Stunted growth and spasmodic coughing are signs of heavy infection.

### Treatment

1. Levamisole (drench, bolus, pellet, or water) 2-5 mg./lb. of body weight.

2. Cambendazole (paste, bolus, crumbles, or pellets) 9 mg./lb. of body weight.

## 5. Nodular Worms

These are called nodular worms because of the nodules or lumps they cause in the large intestine. Four species occur in swine, but all of them are slender, whitish to grayish in color, and one third to one half inch in length. As with other worms, they thrive in warm and moist climates and are endemic in many tropical countries. They are not transferrable to humans.

### Life Cycle

The 4 species of nodular worms affecting swine have similar life cycles. The adult worms are localized in the large intestine of the pig. The female worms deposit large numbers of partly developed eggs that become mixed with the intestinal contents and are eliminated with the feces. With favorable conditions of moisture and temperature, the larvae are infective to pigs. Pigs then become infected by swallowing the larvae while feeding on contaminated ground. In the digestive system of the pig, the larvae travel to the large intestine where they penetrate into the wall and grow for the next 2-3 weeks. They then move into the lumen, or cavity, of the large intestine where they continue to grow. Within 5-7 weeks after being eaten by the pig, the worms are fully grown and have mated and are producing eggs.

### Prevention

Sanitation and pasture rotation are the only practical preventatives.

### Symptoms

It is not possible to identify specific symptoms of this parasite that are different from other parasites. Lab tests are needed for positive diagnosis. General weakness, anemia, emaciation, and diarrhea are sometimes seen.

### Treatment

Thiabendazole, levamisole, piperazines, and dichlorvos are used. For dosages specific to treatment of nodular worms read the label or manufacturer's recommendation.

## 6. Strongyloides (threadworm)

The pig is the only host of this parasite (S. ransomi). These worms are tiny; females are 3 to 4 mm. long. Like many other parasites it thrives in warm and moist climates.

### Life Cycle

The life cycle is as follows: small, embryonated eggs are passed in the feces; at 70°F, they hatch in 12 to 18 hours;

the larvae develop into the infective stage 22 to 24 hours after hatching; the infective larvae penetrate the skin and proceed to the lungs via the bloodstream, thence from the alveoli of the lungs to the bronchi, esophagus, stomach, and small intestine, where they become adults about 7 days after infection. Also, it has been shown that oral ingestion of the infective larvae can produce infection and that S. ransomi is capable of developing a free living generation of adult males and females, which, in turn, develop infective parasitic larvae. The larvae pass through the colostrum from sow to piglets.

### Prevention

Sanitation and selecting dry, unshaded areas for grazing are the only practical ways to prevent this disease.

### Symptoms

Reduced growth rate, diarrhea, vomiting, restlessness, irritability, and even death are symptoms of heavy infestations. Light and moderate infestations may not produce noticeable symptoms. Lab tests are required for positive diagnosis.

### Treatment

1. Thiabendazole: Paste formulation, at 30 to 40 mg./lb. body weight.

2. Cambendazole: (paste, bolus, crumbles, or pellets) 9mg/lb. body weight.

## 7. Stomach worms

Three species of small stomach worms infect swine. Two of the species, A. strongylina and P. sexalatus, are commonly known as "thick stomach worms." These worms are reddish in color and nearly an inch long in the adult stage. The third species, H. rubidus, commonly known as the "red stomach worm" is a small, delicate, slender, reddish worm about one-fifth inch in length. These are not transferrable to man and it is unknown how endemic they are worldwide.

### Life Cycle

It has been proven that the dung beetle serves as the intermediate host for the thick stomach worm. The female worm deposits eggs in the stomach of the pig, with each egg containing a tiny embryo. The eggs pass with the feces to the outside of the body of the pig, then hatch, and the tiny larvae enter the body cavity of various species of dung beetles, the intermediate host. After developing for about a month in the beetle, the larvae become infective to swine. Hogs feeding on contaminated ground then swallow the beetles.

In the stomach of the pig, the parasites leave the beetles and enter the mucus membrane of the stomach, where they grow to maturity. The life history of the red stomach worm differs from that of the thick stomach worm in that no intermediate host is necessary, the infections being directly acquired.

### Prevention

Prevention is solely based on good management, sanitation, and pasture rotation to prevent contact between dung beetles and swine.

### Symptoms

Inflammation and gastric ulcers. Loss of appetite and poor weight gain.

### Treatment

Thiabendazole, levamisole, and dichlorvos are effective against H. rubidus. Carbon disulfide is recommended against P. sexalatus and A. strongylina. Check the label for recommended dosage.

## 8. Thorn-headed worm (Macracanthorhynchus hirudinaceus)

So named because of the presence of rows of hooks--a spiny proboscis--through which it attaches itself to the wall of the small intestine of the pig. They are milk white to bluish in color and cylindrical to flat in shape, the largest being about the size of a lead pencil. They can severely weaken the intestine. They also thrive in warm and humid climates and are common in tropical countries. They are not found in man.

### Life Cycle

Adult female thorn-headed worms produce numerous thick-shelled brownish eggs, each containing a fully developed larva. Each female may produce as may as 600,000 eggs per day at the peak of her egg-producing capacity. The eggs, which pass out with the manure, are very resistant to destruction. White grubs, the larvae of June bugs (or May beetles), serve as the intermediate host. The grubs, feeding on infected manure or contaminated soil, swallow the parasite eggs. The eggs hatch in the bodies of the grubs and in 7-12 weeks develop to a stage that is infective to swine. Pigs rooting in manure or trash piles, rich soil, or low-lying pastures swallow the grubs. The young thorn-headed worms then escape from the bodies of the grubs or adult beetles through the process of digestion and develop to egg-laying maturity.

### Prevention

Sanitation and pasture management designed to prevent the pigs from eating white grubs.

### Symptoms

No special symptoms - general unthriftiness. A heavy infestation can kill young pigs. Post mortem examination will reveal a weakened intestinal wall with swelling or nodules at the point of attachment.

### Treatment

Lavamisole (drench, bolus, pellet, or water formulation) 2 to 5 mg./lb. body weight.

## 9. Trichinosis

This disease is a common public health problem in many different countries of the world. It is caused by T. spiralis and humans acquire the disease by eating infected pork that has not been fully cooked. It is probable that all mammals are susceptible to trichinosis. Although the parasite is often present in the muscle of swine, it does not produce recognizable symptoms. The disease is worldwide, but occurs most frequently in countries where pigs are allowed to free-range and eat uncooked garbage. For more information on its effect on humans refer to Where There Is No Doctor.

### Life Cycle

The adult parasite, which is a round worm from 1.5 to 4 mm. in length, lives in the small intestine of man, hogs, rats, and other mammals. The female worms penetrate into the lining of the intestines where they produce numerous larvae. The larvae pass from the wall of the intestine into the lymph stream, then into the bloodstream, and finally into the muscle cells (particularly affected are the diaphragm, tongue, masseter, and the deltoid muscles). In the muscles, the larvae grow until they are about one-twenty fifth of an inch long, then roll in a characteristic spiral shape, and become surrounded by a capsule. In this environment and stage of development, these larvae may live for years or until the raw or improperly cooked muscle tissue is eaten by man or other species of meat eaters.

### Prevention

1. Killing of rats in the area will help control it.
2. Disposing (burning or burying) of pigs that die.
3. Do not allow pigs to eat uncooked garbage.

4. Fully cook all pork meat before eating it (to at least 170°F).

Obviously, not all of the suggestions made here can be followed in a rural village with traditional (free-ranging) animal husbandry practices. That's why this is a difficult disease to control. Follow the suggestions when and where possible.

### 10. Whipworm (Trichuris suis)

Whipworms are usually found attached to the walls of the cecum and large intestine of swine. They are 1-2 inches in length. The worms have a very slender anterior portion and a much enlarged posterior. The anterior resembles the lash of a whip and the posterior the handle, hence the name whipworm. It is not known how prevalent this worm is worldwide but it does favor warm and moist climates. They are not transmissable to humans.

#### Life Cycle

No intermediate host is required for this parasite. The eggs are produced in large numbers within the hog and shed in the feces. An infective larva develops in the shell, and swine become infected by swallowing the eggs when feeding on soil that has been contaminated. The eggs hatch in the stomach and intestine, and the larvae enter the cecum where they grow to maturity in about 10 weeks or longer.

#### Prevention

Rotation of pastures, plenty of sunlight, and well-drained soils are the only known preventatives.

#### Symptoms

Depending on the severity of the infection, pigs may develop diarrhea or bloody diarrhea, growth may be stunted, and finally the animals may become weak and die. Inflammatory lesions will also be present in the cecum and adjacent large intestine.

#### Treatment

Dichlorvos and Levamisole. Check the label for dosage specific to whipworms.

## External Parasites

### 1. Lice

The louse is a small, flat, wingless insect parasite. There are several species of lice and most species are specific to a particular class of animal. Hog lice do not affect other animals or man. The hog louse

(Haematopinus suis) grow up to 1/4 inch in length. Lice are endemic to all parts of the world. Diseased or poorly fed hogs (commonly true for free-ranging hogs) are more prone to lice than healthy hogs.

### Life Cycle

Lice spend their entire life cycle on the host's body. They attach their eggs or "nits" to the hair near the skin where they hatch in about 2 weeks. Two weeks later the young females begin laying eggs, and after reproduction they die on the host. Lice do not survive more than a week when separated from a pig; but under favorable conditions, eggs clinging to detached hairs may continue to hatch for 2-3 weeks.

### Prevention

It is practically impossible to prevent lice on swine. General sanitation and occasional treatment to keep the number of lice down seems to be the only practical suggestion. Prevent overcrowding in the herd.

### Symptoms

Since lice are blood suckers they cause severe itching, restlessness, and a loss of condition in swine. Pigs may be seen scratching, rubbing, and gnawing at their skin as an indication of lice. Scabs and scaly skin can be seen in severe outbreaks.

### Treatment

Spraying or dipping with anacricide is more effective with swine than dusting. Refer to the attached charts for dosage and names of typical acaracides to use.

## 2. Mites (Mange)

Mites produce a specific contagious disease known as mange (or scabies) These parasites are insect-like and almost invisible to the naked eye. Swine are most affected by the sarcoptic type of mites. With the exception of sarcoptic mites, mites are species-specific and do not normally live or reproduce on a different host. The sarcoptic mite will live on different species. The sarcoptic mite of horse and cow is transferrable to humans. There are 2 chief forms of mange: sarcoptic mange, caused by burrowing mites, and psoroptic mange, caused by mites that bite the skin and suck blood, but do not burrow. The sarcoptic form is most damaging, for in addition to their tunneling, they secrete an irritating poison. The irritation and blood sucking caused by mites retard growth and lower meat production. Mites exist in all parts of the world.

### Life Cycle

The mites that attack swine breed exclusively on the bodies of their hosts. They will live for only 2-3 weeks when removed. The female mite which produces sarcoptic mange- the most severe form of scabies- lays from 10-25 eggs during the egg-laying period, which lasts about 2 weeks. At the end of another 2 weeks, the eggs have hatched and the mites have reached maturity. A new generation of mites may be produced every 15 days. The disease is most common when pigs are closely confined.

### Prevention

The only sure means of prevention is to avoid contact with infected animals or pens.

### Symptoms

Itching, scratching, lack of appetite, crusty or thick skin, and secondary skin infections.

### Treatment

Lindane at a concentration of 0.05 to 0.1% or Malathion at 0.05%. Both should be mixed at these concentration with water when applying.

## 3. Ringworm

Ringworm is a contagious disease of the outer layer of skin. It is caused by microscopic molds or fungi (Trichophyton, Achorion, or Microsporon). All animals and man are susceptible. It is a fairly common parasite worldwide. It is less common in free-ranging hogs than those penned closely together because it is spread through contact.

### Life Cycle

The period of incubation for this disease is about one week. The fungi form seed or spores that may live 18 months or longer in barns or pastures.

### Prevention

Affected animals should be isolated. Everything that has been in contact with infected pigs should be disinfected (impossible at times).

### Symptoms

This disease produces ugly round scaly areas almost devoid of hair around the eyes, ears, side of neck, and tail. It may form gray, powdery crusts that gradually increase in size. The pig will be discomforted by the disease, but the economic losses are so low that it may not warrant treatment.

### Treatment

Tincture of iodine and alcohol can be used to clear up the infection. You may not find that the expense justifies the treatment.

## 4. Screwworm

Screwworms affect all types of livestock and will infect man if given the opportunity. They have been nearly eradicated in the U.S., but are still a problem in many other parts of the world, especially in subtropical and tropical zones. In infested areas, it is one of the most bothersome parasites and can literally destroy herds of animals.

### Life Cycle

The primary screwworm fly is bluish green in color, with three dark stripes on its back and reddish or orange color below the eyes. The fly generally deposits its eggs in shingle-like masses on the edges or the dry portion of wounds. From 50 to 300 eggs are laid at one time, with a single female being capable of laying 3,000 eggs in a life time. Hatching of eggs occurs in 11 hours, and the young whitish worms (larvae or maggots) immediately burrow into the living flesh. There they are feed and grow for a period of 4-7 days, shedding their skin twice during this period. When these larvae have reached their full growth, they assume a pinkish color, leave the wound, and drop to the ground, where they dig beneath the surface of the soil and undergo a transformation to the hard-skinned, dark-brown, motionless pupa. It is during the pupa stage that the maggot changes to the adult fly.

After the pupa has been in the soil from 7-60 days, the fly emerges from it, works its way to the surface of the ground, and crawls up on some nearby object (bush, weed, etc) to allow it wings to unfold and otherwise mature. Under favorable conditions, the newly emerged female fly becomes sexually mature and will lay eggs 5 days later. During warm weather, the entire life cycle is usually completed in 21 days, but under cold, unfavorable conditions the cycle may take as many as 80 day.

### Prevention

Keep the number of wounds on your pigs to a bare minimum. Screwworms must have access to a wound to be able to enter the pig.

### Symptoms

Maggots burrowing in and around a wound producing a wound full of reddish-brown pus that almost completely covers the wound and larvae or maggots. The wound will drain continually. The pus will turn attract house and bow flies.

### Treatment

All wounds should be treated with a smear or spray containing lindane, ronnel, or diphenylamine to prevent the invasion of tissue by fly larvae. If these are not available use a thick petroleum grease to cover the wound.

## 5. Ticks

Ticks are destructive blood-sucking parasites found in most, if not all, countries of the world. In tropical and subtropical zones they can severely damage the profit of an operation. They affect all warm blooded animals including man. After sucking blood they can survive long periods of time without a host. Ticks have been grouped into the "hard" and "soft" categories. Hard ticks have a more damaging effect on livestock.

### Life cycle

There are one-host ticks, two-host ticks, and three-host ticks. With one-host ticks, the larva and nymph live on one host while the adult completes the cycle on a second host. In three-host ticks the engorged larva drops from the host and molts to the nymph on the ground. The nymph attaches to another animal (possibly of another species) engorges again, falls to the ground, and molts to the adult stage.

Hard Ticks: The Cayenne tick is found on swine in Central & South America. The Bont tick (3 host) is found in southern Africa.

The Tropical Bont tick (3 host) is found in Eastern, Central, and West Africa. They are more common in the rainy season that the dry season.

### Prevention

Avoid contact between your swine and wild animals. Avoid grazing swine in areas of brush that are infected with ticks. Remember that in addition to the blood losses to ticks and the resulting stunted growth, that ticks are vectors for many different bacterial and viral infections.

### Symptoms

Ticks are commonly attached near the ears, neck, and flanks but can be found over the entire body during bad infestations. Most swine will tolerate a few ticks but become irritable as their numbers increase. They will rub, scratch, and gnaw at the site of infection. This in turn can cause irritated and raw skin which is prone to secondary infections. Most ticks can be readily seen by the naked eye.

## Treatment

They can, in some cases, be removed by hand. If you practice this then be sure to check yourself out later to see if you have ticks. Treatment with acaricide washes is good for swine. Dusts will not reach all the ticks. A wash or spray could contain: 0.5% malathion or 0.05% lindane or rotenone.

## Table 2-9
## Handy Spray and DIP Guide for Control of Lice of Swine

| Insecticide | Tolerance (p. p. m. in fat unless otherwise indicated) | Min. Days from Last Application to Slaughter | Formulation and Strength[2] | Amount of Formulation per Animal Unless Otherwise Indicated | Where and When to Apply | Safety Restrictions |
|---|---|---|---|---|---|---|
| Carbaryl | — | 7 | WP, 0.5% S | 1 qt. | Spray thoroughly. Repeat as needed. | Do not apply carbaryl more often than once every 4 days or Ciodrin more often than once a week. |
| Ciodrin | — | — | EC, 0.5-1% S<br>EC, 0.15-0.3% S | 1 pt. 1% or 2 pt. 0.5%<br>1-4 qt. | Spray thoroughly. Repeat once a week or as necessary. | |
| | | | EC, 0.1-0.25% S | 1-2 gal. (1 gal. 0.25%) | Repeat application after 7 days. | |
| Coumaphos | 1 meat and fat | — | WP, 0.06% S | Depending on size of animals and amount of hair. | Immerse, spray, or dust thoroughly. Use lindane dusts and DDT dusts and sprays only once, but repeat other treatments after 2 to 3 weeks if needed. | Do not use coumaphos on animals less than 3 months old. Spray animals 3 to 6 months old only lightly. Do not use with synergized pyrethrins, allethrin, or synergist. Do not spray animals for 10 days before or after shipping or weaning or after exposure to disease. Do not apply in conjunction with oral drenches or other medications, such as phenothiazine or with other organic phosphates. |
| DDT | 7 | 30 | EC or WP, 0.5% dip or S<br>10% D | | | |
| Dioxathion | 1 | — | EC, 0.15% dip or S | | | Do not reapply dioxathion or ronnel within 2 weeks. Do not dip animals less than 3 months old in dioxathion. Withdraw bedding treated with ronnel 14 days before slaughter. Do not apply ronnel to animals receiving organic phosphate treatment from any other source. |
| Lindane | 4 | 30 (S)<br>60 (dip)<br>30 (D) | EC or WP, 0.03-0.06% dip or S<br>1% D | | | Do not treat young animals with dips or sprays containing more than 0.03% lindane. Do not dip, spray, or dust animals less than 3 months old with lindane. Do not treat sows within 2 weeks of farrowing or for at least 3 weeks thereafter. |
| Malathion | 4 meat | — | EC or WP, 0.5% dip or S<br>4-5% D | | | Do not use malathion on animals less than 1 month old. |
| Methoxychlor | 3 | — | EC or WP, 0.5% dip or S | | | |
| Ronnel | — | 42 | EC, 0.25% S | | | |
| | | 14 | 5% C | 0.5 lb./100 sq. ft. bedding | | |
| Toxaphene | 7 | 28 | EC or WP, 0.5% S | Depending on size of animals and amount of hair | Spray thoroughly. Repeat after 2 to 3 weeks, if needed. | Do not use toxaphene on animals less than 3 months old. |

[1] This table was taken from *Suggested Guide for the Use of Insecticides to Control Insects Affecting Crops, Livestock, Households, Stored Products, Forests, and Forest Products*-1968 Agri. Handbook No. 331, USDA; with the permission of ARS, USDA.

[2] The following abbreviations are used: [illegible] dust, EC=emulsifiable concentrate, C=granules and S=spray.

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# SWINE GENETICS

## Production

As mentioned previously, the majority of volunteers who find themselves working to improve the production of swine are going to be working in survival production environments where the pigs are free-ranging, of poor genetic stock (creole), and receive minimal care. To introduce an exotic breed of swine into this management environment will not necessarily improve production. There is no "magic" in exotic breeds. They have been bred for increased production through selection of genetic traits that yield the results desired (large hams, quick growth, etc.) by the breeder. However, for the pig to reach its genetic potential, it must have high quality feed, a disease-free environment, good housing, etc. Without these resources, the new breed will not perform as expected and may not produce any better than the local breed of pig would under similar conditions. Remember that, in many ways, production is the opposite of survival genetically. The local breed of pig has been selected genetically for survival and the exotic breed has been selected genetically for production. To clarify this point, let us look at one genetic characteristic: body size.

Since the goal of the farmer involved in commercial production in the states is quick growth and large body size he has selected pigs bred for this. However, large body size requires more than mere genetic selection, it also requires good feeds. The third world farmer, who does not have the good feeds nor the market for such large animals, has bred for small body size because the energy and water requirements for such a pig are reduced. This makes the pig a better survivor in the face of drought and a lack of feed. Generally, small third world farmers are not concerned with production but with survival. Therefore, volunteers should be sensitive to local farmers' needs concerning production and not assume that more is always better. Without improving the feeds, management, disease control, and housing, it is senseless to think that introducing improved breeds will increase production. Volunteers should remember that lowering production costs (and thereby increasing profit margins) is as important a concern for many farmers as is increasing overall production. Improved breeds will not necessarily lower production costs. Heredity and environment must both come together to increase production.

When selecting new exotic breeding stock, it is important to consider whether you want a lard, bacon, or meat type hog.

## Lard Hogs

- These would be favored in countries that use animal fat for cooking or for eating. The back fat of hogs is a favorite dish in Central America.
- These are also preferred in countries where a larger breed of swine is favored.
- The Poland China breed is typical of a lard hog breed.
- These animals tend to be smaller in size, thick, compactly built, and very short of leg.

- This type of hog is prone to small litter size.

## Bacon Hogs

- Bacon type hogs are more common in those areas where the available feeds consist of dairy by-products, peas, wheat, barley, oats, rye, and root crops. They are not common in the tropics. Compared with corn, such feeds are not so fattening. Thus, instead of producing a great amount of lard, they build sufficient muscle for desirable bacon. They are more common in Northern Europe.
- Landrace is the dominant breed worldwide in producing bacon.

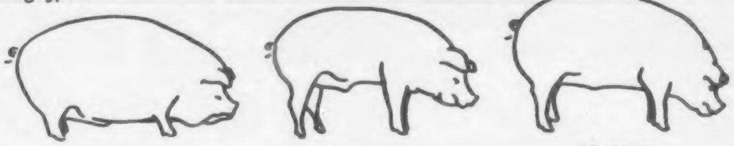
## Meat Hogs

- Meat type hogs are intermediate between lard and bacon hogs.
- Duroc is a popular meat breed that is found in Latin America.
- The U.S. market is dominated by meat hogs.
- Meat hogs have a large body size and high energy requirements.

When calculating selection characteristics for swine, there are six traits to be considered. They are listed below.

1. Litter size
2. Survivability
3. Suckling ability ("Motherliness")
4. Rate of Gain
5. Carcass quality
6. Sunburn

*Hog types.*



*Fat "chuffy" type* *Leggy type* *Meat type*

From: Small-Scale Pig Raising, by Dirk Van Loon. Garden Way Publishing, Charlotte, VT; 1978 with permission.

## Purchase of Breeding Stock

Volunteers and farmers who seek to improve production through cross-breeding of exotics with local breeds are faced with the choice of whether to buy a sow or a boar. If you have limited money to work with, buy the boar. A boar can have so many more offspring during a given season or a lifetime than a sow; he is, from a hereditary standpoint, a more important individual than any one sow so far as the whole herd is concerned. Because of their wider use, therefore, boars are usually culled more rigidly than sows and the farmer can well afford to pay more for a good boar than for an equally good sow.

## Sex-linkage

Sex-linked inheritance may be explained as follows: The genes that determine sex are carried on one of the chromosomes. The other genes that are located on the same chromosome will be linked or associated with sex and will be transmitted to the next generation in combination with sex.

## Cross-breeding

Cross-breeding is the mating of two animals which are members of different breeds. Crossbreeding can be used by volunteers to:

1. Increase productivity of local breeds by cross-breeding with exotics to produce hybrid vigor (heterosis).

2. Produce hogs with a desired combination of traits not available in any one breed.

However, it remains true that any merits that cross-breeding may possess are and will continue to be based on improved "seed stock". Hybrid or crossbred vigor occurs when the desirable genes of each breed are combined and the offspring then take on the better traits of each parent. Hybrid vigor can produce increased litter sizes, livability, and a better growth rate. The 3-way cross is used to produce meat hogs that have hybrid vigor and 3 separate breeds to use as a genetic pool. Most meat hogs commercially raised for market in the U.S. are the results of a 3-way cross. One popular crossing combination is Yorkshire, Duroc, and Landrace. In this system a crossbred sow (Yorkshire and Duroc for example) would be crossed with a Landrace boar. After her litter is weaned she could be crossed with a Hampshire boar for the next generation.

If you use your boar to mate with sows of other farms (or from the streets) in an attempt to improve the genetic stock you may also be exposing your boar to diseases such as brucellosis. Be cautious!

## Creole Breeds

Creole or native breeds are adapted to free ranging environments and survival level production. Such creole or "bush" hogs may be spotted, tend to have elongated snouts, long tusks, long hair, and may be long legged as well. They are well adapted to survival and can be quite prolific. A 12:1 f/g ratio can be found in attempts to feed these breeds. They are the not-too-distant offspring of their wild progenitors. These creole breeds of Southeast Asia, Africa, and Central and South America are descended from one or more of the following wild pigs:

1. The European Wild Boar
2. The Malayan or Philippine pig
3. Tropical river pigs of Africa
4. Giant forest hog of Africa
5. Wart hog of the African plains

## Mixed Breeds

As mentioned, mixed breeds occur when crossing exotics with exotics or exotics with creole breeds. Mixed breeds can be used in moderate to high production level environments and can obtain feed to gain ratios of 8:1 or higher depending on the breeds crossed and the types of feed.

## Exotic Breeds

There are many exotic breeds of swine but I will mention only 5 of the more common breeds here. Exotic breeds can produce as high as a 5:1 f/g ratio. They are appropriate for moderate to high production environments.

1. American Landrace
2. Poland China
3. Duroc
4. Yorkshire
5. Hampshire

## 1. Landrace

The Landrace breed originated in Denmark. The breed is white in color, although black skin spots or freckles are rather common. The breed is characterized by its very long side, square ham, relatively short legs, trim jowl, and medium top ears. It is noted for prolificacy and for efficiency of feed utilization. They are to be found in Central America and other continents where improved breeds are being worked with in tropical production. They typically farrow and wean large litters.

## 2. Poland China

Modern Poland China pigs are black in color with six white points--the feet, face, and tip of the tail. Mature boars and sows can weigh from 600 to 1,000 pounds. They have an excellent rate of gain and demonstrate good survival characteristics.

## 3. Duroc

The Duroc breed is native to the Northeast U.S. The Duroc is red in color, with the shades varying from light to dark. It is a meat type hog. It has the "flop" ears. Durocs produce litters that survive quite well and have an excellent rate of gain. They are also known as being fierce in the defense of their young.

## 4. Yorkshire

This breed is native to England and is a "bacon" type breed. Yorkshires may or may not be entirely white in color. The face is often slightly dished and the ears are erect. Yorkshire sows are noted as good mothers that farrow and raise large litters. They forage and gain weight well. However, this breed does not survive well in low management conditions.

## 5. Hampshire

The most striking characteristic of the Hampshire is the white belt around the shoulders and body, including the front legs. This is an active breed and the sows have the reputation of raising a high percentage of the piglets farrowed. They are not, however, as large a breed as others and the mature boar or sow will weigh less than other breeds. They also gain weight less quickly than other breeds. They are an American breed from Kentucky. They tend to be short of body with smaller hams. They have erect ears.

# SWINE HOUSING AND EQUIPMENT

In Latin America and most of Africa, where pigs are raised by subsistence farmers, the pigs are allowed to free-range and scavenge off of whatever feeds and garbage they find. In Southeast Asia pigs are more commonly penned and fed rather than being allowed to free-range. Neither of these two systems is inherently "better" than the other. Both are systems that have developed over time as a response to local culture and conditions. Most importantly, they are systems of husbandry that work and are appropriate to the local conditions. Listed below are some of the advantages and disadvantages of the free-ranging system of swine husbandry.

## Advantages

1. Feed scraps and garbage available locally gets consumed and produces meat.
2. The feed is free and therefore production costs are nearly nonexistant.
3. People do not have to spend much time caring for the pigs.
4. There is no need for expensive housing and feeding equipment.
5. The pigs are not competing with humans for scarce cereal grains.

## Disadvantages

1. The production of meat tends to be very low.
2. The pigs harbor diseases and parasites that are transmittable to humans and generally lower the standards of public health.
3. They burn off a lot of energy looking for food that could be used to produce meat or fat.
4. They are subject to greater predator losses than if they were penned. .
5. There is no control over breeding or genetics in a free-ranging environment.

For volunteers who are sent to work in sophisticated or "high-tech." production environments as specialists in swine production, controlled environments and housing will be a major concern. However, most volunteers who work on improving swine production do so with subsistence farmers who have few resources. For those few "specialist" volunteers, I suggest that they obtain the Swine Science book by M.E. Ensminger as a resource. This particular writing is geared for the generalist volunteer who will be involved in a less production oriented system of animal husbandry.

For the generalist volunteer working with subsistence farmers who produce a limited amount of cereal grains, it is my contention that housing of pigs is not a major concern. Of the five components of livestock production (*nutrition, management, diseases and parasites*, genetics, and housing), I consider housing to be the least important in terms of increasing production. If the goal of the farmer and the volunteer is to increase the production of meat from pigs, then an investment of money and time should be given to the other 4 components before housing, because they will yield better results. It is totally inappropriate to invest in sophisticated housing and labor-saving devices for pigs when working with local or creole breeds while not having solved all the problems relating to their feeds and nutrition. Unless there is a real excess of cereal grains being produced in your area, it is probably not appropriate to attempt to move farmers from their free-ranging system of husbandry to one of raising pigs in confinement. When pigs are confined, the farmer and the volunteer have committed themselves to a higher level of production that involves feeding the pigs daily, worrying about production costs and the scarcity of grains, marketing of pigs for profit, and improving the levels of husbandry as well as attempting to improve the genetic strains or breeds of hogs that you are working with. To go from a free-ranging or survival level of production to a moderate level is a major step and not one that volunteers should promote unless they are very sure that all the resources needed to do so are available.

If the volunteer finds him/herself in a situation where it is indeed appropriate to pen the pigs up and feed them, or it is a local custom that swine are raised in confinement, then there are many points to consider in coming up with a design for housing that is appropriate to local resources, culture, and climate. The incredibly diverse possibilities that all of this world's villages hold in the way that local resources, culture, and climate come together (coupled with my own limited knowledge of the implications of such diverse conditions) make it impossible for me to offer any single design for swine housing that would be appropriate in all cases. It is the task of the volunteer and local farmers (who would know far better than I do) to determine what is "appropriate" in a given situation. However, I offer the following points to be considered in your decision concerning the type of shelter you might provide to pigs.

1. Visit other farmers who already are raising pigs in confinement and see what designs and materials they are using.

2. Use materials that are available locally (either free or at minimal cost) such as bamboo.

3. Do not invest much money in housing for pigs.

4. Make sure that the pigs that are confined have protection (shade) from the sun. This can be provided by a thatched roof or trees.

5. Provide a water source or a mud "wallow" for the pig to cool in as a protection from the heat.

7. Design the pen in such a manner as to protect the pigs from predators.

8. The pen should be kept near the farmer and the source of feed. This creates the possibility of increased access and (hopefully) better care for the pig.

9. Consider the following space requirements:

   - Mature sows, gilts, and boars require 15-20 square feet of space each.
   - Gilts with piglets and mature sows with piglets require at least 50 to 65 square feet of space.
   - Weaner pigs to pigs of 75 lbs. require 5-6 square feet.
   - 75 to 125 lb. pigs need 6-7 square feet.
   - 125 to 200 lbs. pigs need 8-10 square feet each.

## Disinfecting

In regards to all swine housing and equipment (feeders, waterers, and farrowing crates), it is true that they need to be disinfected from time to time. If you are rotating pastures or pens, the pens and all equipment should be disinfected. If you have a buildup in parasites or a disease outbreak you also need to disinfect. Scrubbing with soap and water, followed by washing with a disinfectant (such as chlorine or iodine), and then sundrying for 48 hours is effective in controlling most diseases and parasites.

## Equipment

### Farrowing Crate

The purpose of a farrowing crate is to provide an area where the sow can remain while farrowing which affords protection to the piglets and allows the farmer to tend to the sow during the farrowing. Newborn piglets are often not quick enough to avoid being laid upon by a sow as she rolls. When this happens the piglet can be squashed or may suffocate. Farrowing crates or guard rails along the wall of the farrowing pen create a space where the piglet can lay down while nursing and still be protected from the weight of the sow. Each farrowing crate may be from 4-1/2 to 5 feet wide and 8 feet long. These widths allow from 1-1/4 to 1-1/2 feet of space on both sides of the 2-foot-wide sow stall for the piglets. The bottom guard rail should be about 15-18 inches off the ground. The size of the farrowing crate also depends on the size of the sow and local breeds.

The crate can be built out of a variety of materials such as thick bamboo, wood, or pipe. The important thing to remember is that the crate be built out of as inexpensive (yet functional) material as is available. The picture included is of a crate built with plywood but the idea is applicable to any building material.

## FARROWING STALL

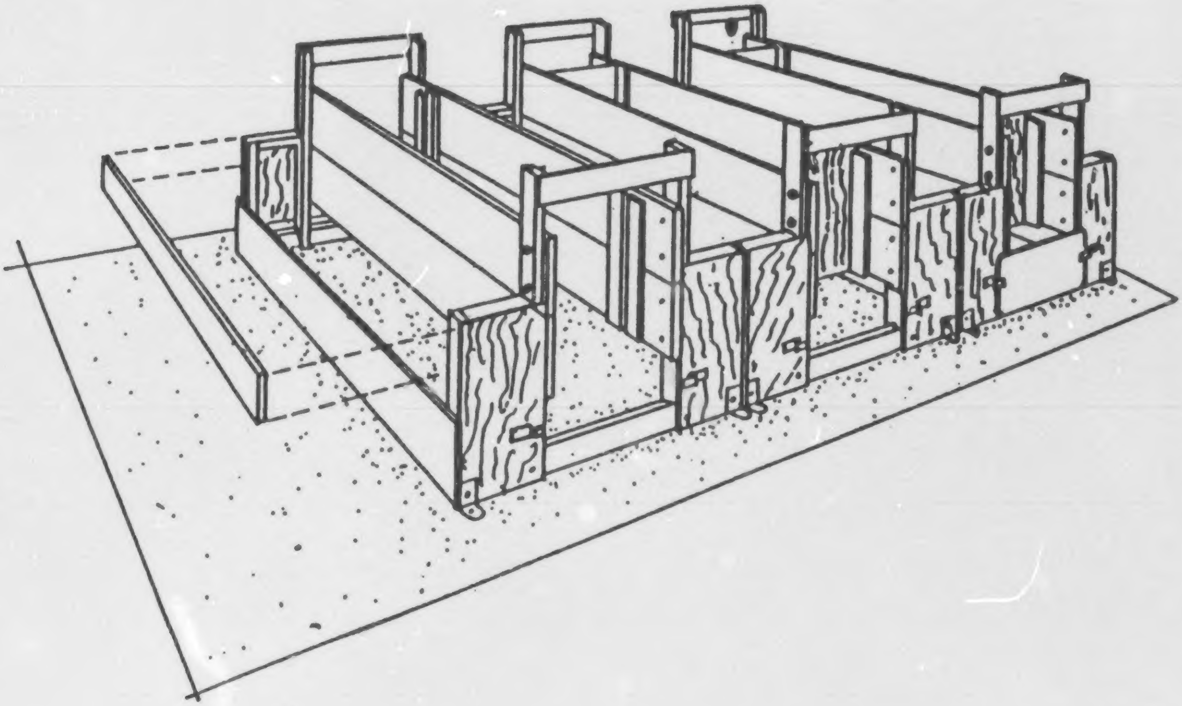
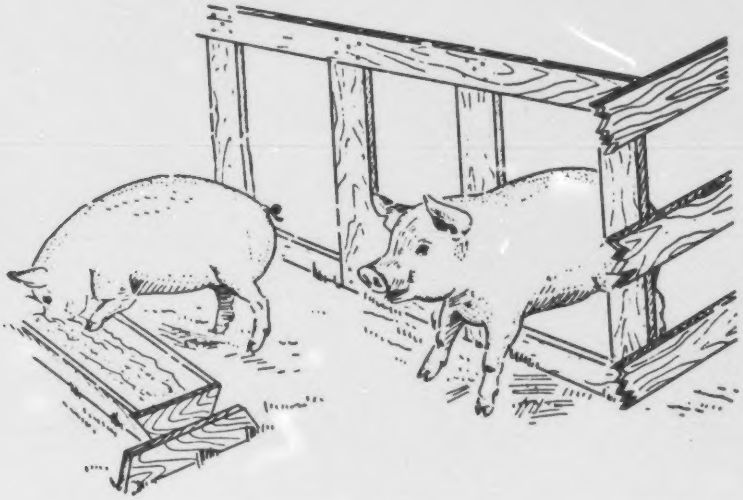


Illustration 2-6

## Feeders

One of the best feeders is the trough. This type of feeder is good for either dry feed or a wet mash. They can be built cheaply out of wood. They should be built so that they form a V which causes the feed to fall to the bottom, prevents the pigs from standing in it, and may reduce waste. The trough should also have slats spread along the top of it to prevent the pigs from lying in the feeder. The trough should be supported by wide end pieces that prevent it from being turned over and the feed wasted. Refer to the 2 illustrations for possible design ideas. Creep feeders are designed so that the piglets can be fed in an area where the sow cannot enter and feed. Pigs that feed directly off the ground, rather than from a trough feeder, are more subject to infection by parasites. One to two feet of linear space per pig on a feeder is needed (depending on the size of the pig).



Creep-feeding is the practice of feeding concentrates to young pigs in a separate enclosure away from their dams. (Drawing by R. F. Johnson)

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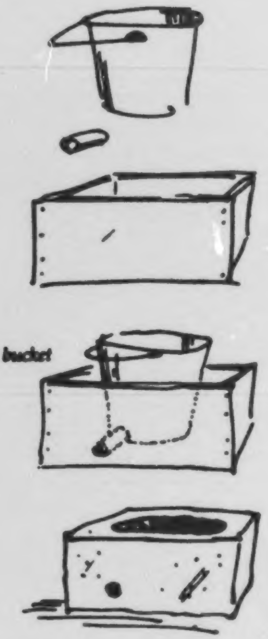
## Waterers

Illustration 2-7

*Concrete trough or watering bowl for single hog.*



*Bucket weighted with sand*
*3" piece of pipe or hose to*
*provide a drain.*

*Wooden box form*

*After pouring 2" concrete floor in box, insert bucket*
*and pipe and fill box with concrete.*

*Allow to set, then remove bucket.*
*Trough will slip out of greased form.*
*Put wooden plug in*
*drain hole.*

This is a good design for a practical, low-cost, and easy to construct waterer for pigs. The advantages of this design is that it is easy to clean and heavy enough not to be constantly tipped over by pigs. Also, pigs can not lay down in this waterer to cool themselves, thereby contaminating their drinking water. Other ideas for building waterers can be gained from local farmers and their creative uses of bamboo and wood. One to two linear feet, depending on the size of the pig, is needed for watering space.

From: Small-Scale Pig Raising, by Dirk Van Loon. Garden Way Publishing. Charlotte, VT; 1978 with permission.

# RABBIT NUTRITION

Rabbits are nonruminant herbivores. By this, I mean that they are simple stomached animals (like chickens and horses) rather an ruminants (like goats and cattle). Their digestive anatomy and physiology closely resemble the horse. Because they are not ruminants, they do not have the ability to synthesize amino acids from nonprotein nitrogen (NPN) such as urea. This is because NPN sources are degraded and absorbed in the small intestine and then passed in the urine before the NPN ever reaches the cecum where it might be transformed into bacterial protein. Rabbits do, however, have an enlarged cecum which gives them the ability to utilize fibrous plant material such as grass or legume hay.

It is this ability to utilize fibrous plant material which makes them an important animal to work with in the development of livestock production. They can eat locally grown feeds (such as green vegetable waste, grass, and legumes). In doing so, they are able to produce a protein rich meat without competing with humans for grains such as corn, oats, wheat, rice, or millet. This is important in a world that lacks protein for humans. It should be remembered though that, as production demands (for fur, growth, reproduction, and lactation) are increased, the amount of energy in the diet must also be increased through adding cereal grains to the feed. The feed/gain ratio of rabbits can vary from 3:1 (with a balanced ration) to 8:1 when being fed just grass. Rabbits being raised in third world villages where the farmer does not feed them grains, but feeds them locally grown legumes and grasses, may get a 5 or 6:1 feed/gain ratio.

It should be remembered, however, that rabbits are not a "miracle" animal and there are many climatic and cultural considerations that might preclude them being raised in a given village. Before a volunteer invests time or money in a rabbit project, he/she should consider the following points which may limit rabbit production in the tropics.

1. Rabbits are delicate animals that are clearly outside their climatic zones when placed in the hot and/or humid tropics. Heat and humidity can be killers of rabbits.

2. There is very little market for rabbit fur in the tropics.

3. If rabbits are kept in a very clean environment, they will be prone to disease and parasite problems.

4. Feeding too much fresh green roughages to rabbits can give them diarrhea which can lead to reduced weight gains, dehydration, and even death.

5. Rabbits have difficulty eating feeds such as starchy roots or grains that have been ground too finely.

6. Rabbits tend to grow better and are healthier during the dry season in the tropics than during the rainy season when they are subject to disease and parasite losses. The problem here is that grasses and other feeds that rabbits eat are far more abundant in the rainy season

than in the dry season. Therefore, it requires planning and the storage of feeds that are abundant in the wet season to be fed to the rabbits during the dry season. In areas such as the Sahel where green vegetation is often lacking due to drought, there may be a shortage of available feeds for rabbits.

7. Rabbits, in many cultures, are considered too "cute" to eat. Here, the cultural considerations preclude the raising and eating of rabbits.

8. Also, rabbits are highly stressed by noise and by being mishandled. The husbandry of rabbits requires that the farmer (or whoever is taking care of them) be gentle and not subject them to abuse.

Advantages of rabbits over other animals include:

1. They can be raised on very little land.

2. They can effectively utilize fibrous plant material.

3. They convert feed more efficiently to protein than larger animals like cattle and swine.

4. They reproduce very quickly.

5. Their feces is a good source of fertilizers or can be used in earthworm production.

6. It costs very little money to get started with rabbits.

## Energy

The important point to remember here is that increased production demands require increased energy. In order for rabbits to grow and bear young they must be fed well. Breeding does and bucks can be maintained on less energy than can rabbits in production. Fat, as a source of energy, can be used in rabbit rations, but should be limited from 2 to 5% in order to avoid scours.

## Protein

Production requires high levels of good quality protein (legumes). Rabbits raised on grass will not grow and produce as well as those raised on legumes (alfalfa, peanuts, soybeans, leucaena, stylo, and wingbeans). Coprohagy aids rabbits in efficiently utilizing protein.

The nutrient requirements listed on the following page are taken from the NRC rabbit text. They are requirements for high level production. These values are based on an as-fed standard. The requirements for survival clearly would be lower but we are not sure how much lower.

Rabbit nutrient requirements for:

| | TDN | CP | Lysine | Ca | P |
|---|---|---|---|---|---|
| Maintenance | 55 | 12 | * | * | * |
| Gestation | 58 | 15 | * | .45 | .37 |
| Lactation | 70 | 17 | * | .75 | .50 |
| Growth | 65 | 16 | .65 | .40 | .22 |

* Required, amount unknown

Included below are 2 sample feed rations for high level production.

Fryer (growth) ration

| Feedstuff | % | TDN | CP | Lysine | Ca | P |
|---|---|---|---|---|---|---|
| Alfalfa hay* | 50 | 20 | 6.6 | .27 | .56 | .10 |
| Corn, grain | 23.5 | 19.5 | 2.2 | .05 | -- | .06 |
| Barley, grain | 11 | 8.2 | 1.4 | .05 | -- | .04 |
| Wheat bran | 5 | 2.8 | 0.7 | .03 | -- | .06 |
| Soybean meal | 10 | 8.2 | 4.6 | .29 | .03 | .06 |
| Salt | 0.5 | -- | -- | -- | -- | -- |
| Totals | 100% | 58.7 | 15.5 | .69 | .59 | .32 |

* Alfalfa hay--not meal--Feed value from NRC Rabbit text pages 18 and 19 Line #6.

This ration is given on an as-fed basis.

Use pages 18 to 23 to obtain the TDN, CP, Lysine, Ca, and P feed values for these feed ingredients in the NRC rabbit text.

Ration for a pregnant doe.

| Feedstuff | % | TDN | CP | Lysine | Ca | P |
|---|---|---|---|---|---|---|
| Alfalfa hay | 50 | 20 | 6.6 | .27 | .56 | .10 |
| Oats, grain | 45.5 | 29.6 | 5.5 | .15 | .03 | .15 |
| Soybean meal | 4 | 3.3 | 1.8 | .12 | .01 | .02 |
| Salt | 0.5 | -- | -- | -- | -- | -- |
| Totals | 100% | 52.9 | 13.9 | .54 | .60 | .27 |

## Table 3-1
## Rabbit Mineral Chart

| Minerals Which May Be Deficient Under Normal Conditions | Conditions Usually Prevailing Where Deficiencies Are Reported | Functions of Mineral | Some Deficiency Symptoms |
|---|---|---|---|
| **Major or macro minerals:** | | | |
| **Salt** (sodium and chlorine, NaCl) | Negligence, for salt is cheap. | Sodium and chlorine help maintain osmotic pressure in body cells, upon which depends the transfer of nutrients to the cells and the removal of waste materials. Also, sodium is important in making bile, which aids in the digestion of fats and carbohydrates; and chlorine is required for the formation of hydrochloric acid in the gastric juice so vital to protein digestion. | Depressed growth. |
| **Calcium** (Ca) | Rations of grass hay and farm grains. | Essential for development and maintenance of normal bones and teeth. Important in blood coagulation and lactation. Enables heart, nerves, and muscles to function. Regulates permeability of tissue cells.<br>Affects availability of phosphorus and zinc. | Rickets; tetany; brittle bones. |
| **Phosphorus** (P) | High legume forage ration without supplemental phosphorus. | Essential for sound bones and teeth, and for the assimilation of carbohydrates and fats. A vital ingredient of the proteins in all body cells. Necessary for enzyme activation. Acts as a buffer in blood and tissue.<br>Occupies a key position in biologic oxidation, and reactions requiring energy. | Rickets; tetany; brittle bones. |
| **Magnesium** (Mg) | | Necessary for many enzyme systems and for proper functioning of the nervous system.<br>Closely associated with the metabolism of calcium and phosphorus. | Poor fur growth; fur chewing; hyperirritability. |
| **Potassium** (K) | | Essential for proper enzyme, muscle and nerve function, cecal microorganism activity, and appetite. | Muscular dystrophy. |
| **Trace or micro minerals:** | | | |
| **Cobalt** (Co) | Feeds from cobalt-deficient areas (in Fla., Mich., Wisc., N.H., Mass., Penn., N.Y., and Alberta, Canada). | Constituent of vitamin $B_{12}$. | Anemia. |
| **Copper** (Cu) | | Copper, along with iron, is necessary for hemoglobin formation, although it forms no part of the hemoglobin molecule of red blood cells. | Anemia; graying of hair. |
| **Iodine** (I) | Feeds grown in iodine-deficient areas. | Needed for the production of thyroxin, an iodine-containing hormone that regulates metabolic rate. | |
| **Iron** (Fe) | | Necessary for formation of hemoglobin, an iron-containing compound which enables the blood to carry oxygen. Also, important to certain enzyme systems. | Microcytic and hypochromic anemia. |
| **Manganese** (Mn) | Excess calcium and phosphorus decreases absorption of manganese. | Considered essential in utilization of calcium and phosphorus, for proper functioning of mammary glands and normal reproduction. | Abnormalities of the skeletal system. |
| **Zinc** (Zn) | | Component of several enzyme systems and also required for normal protein synthesis. | Weight loss, alopecia, graying of hair, dermatitis, low hematocrit, reproductive problems. |

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[1] As used herein, the distinction between "mineral requirements" and "recommended allowances" is as follows: In mineral requirements, no margins of safety are included intentionally, whereas in recommended allowances, margins of safety are provided in order to compensate for variations in feed composition, environment, and possible losses during storage

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Table 3-1
Rabbit Mineral Chart
Page 2

| Mineral Requirements[1] Mineral Content of Ration | Recommended Allowances[1] | | Practical Sources of the Mineral | Comments |
|---|---|---|---|---|
| | Daily Nutrients/ Animal | Percent of Total Ration | | |
| *0.5%<br>Salt (NaCl) | | 0.5–1.0 | Salt spools.<br>Can be added to feed. | Sodium and chlorine are low in feeds of plant origin.<br>There is little danger of overfeeding salt unless a salt-starved animal is suddenly given access to too much salt or if liberal amounts of water are not available. |
| Variable according to age and production (see Table 26-1).<br>Calcium (Ca) | | 0.4–1.0 | Ground limestone or oystershell flour.<br>Where both Ca and P are needed, use bone meal, dicalcium phosphate, or defluorinated phosphate. | The Ca:P ratio should be maintained close to 1:1, although 2:1 is acceptable when the higher calcium content is due to the presence of legume. Where there is a shortage of calcium in the ration, it is withdrawn from the bones. |
| Variable according to age and production (see Table 26-1).<br>Phosphorus (P) | | 0.22–0.50 | Monosodium phosphate.<br>Where both Ca and P are needed, use bone meal, dicalcium phosphate, or defluorinated phosphate. | (Same as stated for Ca under "Comments" above.) If plenty of vitamin D is present, the ratio of Ca:P becomes less important. Apparently phosphorus cannot be withdrawn from the bone. |
| *300–400 ppm<br>Magnesium (Mg) | | 0.03–0.04 | Magnesium sulfate.<br>Magnesium oxide. | In high Ca diets, Mg may become deficient due to interference from the Ca in absorption. |
| *0.6%<br>Potassium (K) | | 0.6 | Potassium chloride.<br>Roughages. | |
| Cobalt (Co) | | | Cobalt chloride, cobalt sulfate, cobalt oxide, or cobalt carbonate. | |
| *3 ppm<br>Copper (Cu) | | 0.00003 | Trace mineralized salt containing copper sulfate or copper carbonate. | |
| *0.2 ppm<br>Iodine (I) | | 0.2 ppm | Iodized salt. | |
| Iron (Fe) | | 0.0050[2] | Trace mineralized salt. | |
| Variable according to age and production (see Table 26-1).<br>Manganese (Mn) | 1 mg for growing animals;<br>0.3 mg for mature animals. | 0.000025–0.000085 | Trace mineralized salt. | Manganese is needed for growth and reproduction of most animals. |
| Zinc (Zn) | | | Zinc carbonate.<br>Zinc sulfate. | |

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or processing. Where preceded by an asterisk, the mineral requirements, allowances, and other facts presented herein were taken from *Nutrient Requirements of Rabbits*, 2nd rev. ed., NRC-National Academy of Sciences, 1977.

[2] Requirements for the horse as stated in *Nutrient Requirements of the Horse*, 3rd rev. ed., NRC-National Academy of Sciences, 1973.

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## Macro-Minerals

### 1. Salt

Rabbits like salt and iodized salt should be 0.5 to 1% of their ration. Salt spools can be placed in cages to satisfy the rabbits' needs, but the salt is corrosive to wire cages.

### 2. Calcium and Phosphorus

Rabbits absorb calcium efficiently. An excess of calcium in the feed should be avoided because it can effect the absorption of other minerals (primarily magnesium and phosphorus). Rations should have a range of 1:1 to 1:5:1 between calcium and phosphorus. Imbalances can occur if the ratio is too low or too high. Low phosphorus in the feed can retard growth, lower conception rates, and weaken bones of rabbits.

The following six points should be considered in producing a ration of rabbits:

a. The cereal grains and their by-products and straws, dried mature grasses, and protein supplements of plant origin are low in calcium.

b. The protein supplements of animal origin and legume forage are rich in calcium.

c. The cereal grains and their by-products are fairly high or even rich in phosphorus, but a large portion of the phosphorus is not readily available.

d. Almost all protein-rich supplements are high in phosphorus. But, here again, plant sources of phosphorus contain much of this element in a bound form.

e. Beet by-products and dried, mature non-leguminous forages (such as grass hays and fodders) are likely to be low in phosphorus.

Proper absorption and utilization of calcium and phosphorus is dependent on 3 factors:

a. An adequate supply of calcium and phosphorus in an available form.

b. A suitable ratio between them (somewhere between 1 to 2 parts calcium to 1 to 2 parts phosphorus).

c. Sufficient Vitamin D to make possible the assimilation and utilization of the calcium and phosphorus.

### 3. Magnesium

Rabbits suffering from the lack of dietary magnesium exhibit poor growth, fur-chewing habits, and hyper-irritability. A number of minerals in the diet are interrelated; and what might seem to be an adequate level of magnesium may actually be a deficiency due to an excessive amount of another mineral with which it is competing for absorption and utilization (such as calcium). Under normal conditions, 0.03 to 0.04% magnesium in the diet should be adequate.

### 4. Potassium

A form of muscular dystrophy which resembles a deficiency of vitamin E occurs in rabbits suffering from a deficiency of potassium. Generally, a diet consisting of 50% roughage is adequate in fulfilling the potassium requirement (0.6% of the ration) of rabbits.

## Micro-Minerals

### 1. Cobalt

Cobalt is the central element of Vitamin $B_{12}$. Rabbits use cobalt in the cecum to synthesize $B_{12}$.

### 2. Iodine

The need for iodine by rabbits has been established but the amount needed has not been determined. It is best to use iodized salt when adding salt to a ration if it is available.

### 3. Iron and Copper

Both are required to prevent anemia.

### 4. Manganese

The manganese requirement for rabbit rations is 3.9 mg/lb. of growing ration, 1.1 mg/lb of maintenance ration, 1.1 mg/lb of gestation ration, and 1.1 mg/lb of lactation ration. Deficiencies of manganese in rabbits can cause bone deformities such as crooked legs, brittleness, decreased weight, and decreased size.

### 5. Zinc

The need for zinc in the diet has been established but the amount needed has not been determined. Deficiency symptons include lowered feed consumption, weight loss, graying of hair, and reproductive problems.

## Water Requirements of Rabbits

The water requirements of rabbits are influenced by a number of factors including:

1. Temperature and humidity. As the temperature and humidity increase, the demand for water will increase for the rabbit to be able to shed heat and avoid dehydration.

2. Stage of production. A doe with a litter of 7 can drink up to one gallon of water per day. When it is possible, all rabbits should be given all the water they can drink. This may not always be possible--especially in the Sahelian countries.

3. Feed composition. Feeds that are high in protein and fiber (such as legume hays) increase the need for water because of the increased need to excrete end products produced in the digestion and metabolism of these feeds. Providing fresh, green, and succulent feeds into the ration provides an additional source of water. However, such feeds (fresh forages) contain a high amount of water, which may limit the amount of feed the rabbit is able to eat and they can cause diarrhea.

Fresh clean water should be available to rabbits at all times. Water bowls should be cleaned and disinfected regularly to prevent the spread of parasites and disease.

## Non-nutritive Factors of Feeds

### Fiber

Breeding bucks and does that are not being bred currently and are being fed a maintenance diet, can receive up to 16-22% fiber in their rations. However, gestating does, lactating does, heavily used breeding bucks, and growing fryers should receive only 12-16% fiber because of the greater need for digestible nutrients. Such fiber should be left in a coarse form because if it is too finely ground, it may cause diarrhea. Roughage (fiber) in the diet can also reduce the incidence of fur-eating.

### Rabbit Feeds

1. Energy feeds. These include cereal grains such as corn, barley, buckwheat, oats, rye, wheat, and the grain sorghums.

2. Protein supplements. Fish and animal by-products are seldom used as protein supplements in rabbit rations due to unavailability, high cost, and low palatability with rabbits. Oilseed meals are commonly used such as soybean meal, sesame meal, linseed meal, and cottonseed meal.

3. Dry Forages. These can be a main part of the ration. Hays can be used to lower the cost of feeding rabbits. Hay that is moldy or contains dirt can cause the rabbit to be more susceptible to disease. All forages should be collected in areas where other animals (such as swine and cattle) are not grazing or the forage may be contaminated with parasites.

4. Legume Hays. These are the best feed for rabbits. They are high in protein and vary palatable. A good quality legume hay can be used as the sole feed for rabbits on maintenance diets. Forty percent of the ration for pregnant does and lactating does can be legume hay. Examples of legume hays would include leucaena, alfalfa, clover, vetch, kudzu, cowpeas, soybeans, and peanuts.

5. Grasses. Fresh grasses are high in water and bulk and may need to be supplemented (if it is appropriate to the project's level of development) with grains to prevent nutritional deficiencies. Rabbits may have a fill problem as well. The source of the grass should be checked to make sure it is parasite free.

## Miscellaneous Feeds

In attempting to introduce the raising of rabbits or trying to increase the production of existing rabbit operations, volunteers should be careful to ensure that it is profitable for those involved. In order to keep the rabbit operation profitable it is good, particularly in low to moderate production environments, to use locally grown, inexpensive feedstuffs such as garden and table scraps. This will lower your feed and production costs. Garden trimmings (carrots, cabbages, etc.) can be used but fat, meats, and spoiled foods should not be used.

## Miscellaneous Roughages

Peelings from starchy roots (cassava, enyam, taro, and potatoes), pulp and peelings from citrus fruit, and other locally available low cost feeds can be used.

## Roots and Tubers

The addition of roots and tubers to the rations of rabbits can be beneficial, especially in the dry season when fresh greens are not available. However, the water content of roots and tubers tend to be quite high (about 90%), and the protein level is quite low (1 to 4%). Thus, the volunteer should not incorporate too high a level of them in the ration. A deficiency in some of the nutrients may result when feeding roots and tubers, because rabbits preferentially eat this type of feed first, subsequently neglecting the higher quality feeds. For this reason, the daily allowance of roots and tubers in a maintenance ration should be limited to 1.5% of body weight. Rabbits in production should not be fed any roots or tubers.

## Shrubs and Trees

Occasionally, twigs from woody plants can be given to rabbits. While the nutritional value of such feeds may be doubtful, they provide the rabbit with something on which to chew (other than the cage) which serves to dull their growing teeth, and perhaps some additional fiber.

## Feeding Rabbits

The feed/gain ratio that a volunteer gets with his/her rabbits depends on what the rabbits are being fed, the health of the rabbits, and other stresses that the rabbits are exposed to. The f/g ratio varies from 3:1 in very well managed projects to 8:1 in projects where the feed is of poor quality or of short supply.

### Dry Does and Herd Bucks

Because these rabbits are not in production they can be given a maintenance ration that is adequate to maintain their health but not allow them to become fat. Legume hay is preferrable. If it is not available or is too expensive, then grass hay can be used and supplemented with 3-4 oz. of grains of each 8 lbs. of liveweight daily.

### Pregnant Does

If pelleted feed is available given 4-5 oz. daily for the first 2 weeks of gestation, then increase it to 6 oz. daily during the last 2 weeks of gestation and during lactation. If pelleted feed is unavailable--provide fresh or sun dried greens such as legumes and/or grasses and supplement with 6-7 oz. of grains daily.

### Lactating Does

Lactating does require very high quality feed due to the high nutrient demands placed on them. Either a complete pelleted ration or a combination of good quality hay and supplement will provide the needed energy and protein. Does fed less nutritious food supply will not produce as well. If you, as a volunteer, cannot provide this kind of diet to your does, then you should be realistic in your expectations about the kind of production you will receive. After the young are weaned, the doe can be returned to a maintenance ration.

### Fryers

For medium-sized breeds (New Zealand and Californians) 2-4 ozs. of a pelleted supplement daily and free-choice of good quality hay will be adequate. If a complete pelleted ration is to be used, they should be fed 4-6 ozs. daily. Fryers will not grow well on starchy, low protein diets.

## Feeding Methods

A standard rule of thumb is that rabbits should never be exposed to radical changes in their diet. If feed changes are to be made, they should be made gradually, taking as long as 10 days. If the change occurs too quickly, the rabbits will eat less or not at all until they become accustomed to the new food and it becomes palatable to them. As a consequence of the stress of a new ration, rabbits may lose weight and be more susceptible to other stresses.

### Hand-Feeding

While this method of feeding involves considerable time and labor, it enables the volunteer to keep a close watch on the general health and feeding habits of his/her rabbits. It allows the volunteer to continue to learn more about rabbits through close contact. This method can best be justified in small operations.

Rabbits can be fed once, twice, or three times daily. Local customs and practices will have an influence on your decision of when and how often to feed the rabbits. A once-a-day feeding practice is good if your goal is to lower the amount of labor. Also, the rabbits are more likely to maintain an active appetite if they are allowed to clean up their feed before the next feeding. Since rabbits eat more during the night hours, a once-a-day feeding should be offered in the evening. If more than one daily feeding is used, the last feeding of the day should provide the largest quantity of feed. The number of feedings is not critical, but it is important that the time of feeding be regular from day to day. Rabbits are creatures of habit, and any break of routine can cause digestive problems.

### Self-Feeding

Growth tends to be more rapid and efficient in self-fed rabbits than those that are fed by hand. This improved growth rate is due to the fact that self-fed rabbits have access to feed at all times; consequently, they eat more frequently and chew their feed more thoroughly. Rabbits that are on maintenance rations may consume more feed than necessary if feed is provided ad-lib. Thus, only lactating does, and fryers 4-8 weeks of age should be fed free choice.

Table 3-3

Vitamin Chart

| Vitamins Which May Be Deficient Under Normal Conditions | Conditions Usually Prevailing Where Deficiencies Are Reported | Functions of Vitamins | Some Deficiency Symptoms |
|---|---|---|---|
| **Fat-soluble vitamins:** | | | |
| A | When on high forage rations that have been stored a long time and lost their carotene value. | Promotes growth and stimulates appetite.<br>Assists in reproduction and lactation.<br>Keeps the mucous membranes of respiratory and other tracts in healthy condition.<br>Makes for normal vision. Prevents night blindness. | Retarded growth, neural lesions, ataxia, xerophthalmia, and impaired reproduction.<br>Young rabbits from deficient mothers may be hydrocephalic. |
| D | In confinement rearing where the rabbits do not have access to sunlight or sun-cured hay. | Assimilation and utilization of calcium and phosphorus, necessary in normal bone development—including the bones of the fetus. | Rickets. |
| E | | Serves as insurance against destruction of vitamin A.<br>Makes for improved reproduction.<br>Protection of cellular lipids from oxidation. | Nutritional muscular dystrophy of skeletal and cardiac muscle, paralysis, and fatty livers. |
| K | Intestinal disorders or when antibiotics are used. | Concerned with blood coagulation. | Hemorrhaging and abortion. |
| **Water-soluble vitamins:** | | | |
| Biotin | Occurs when raw egg white is fed over an extended period. | Serves as a cofactor in carboxylation reaction. | Loss of hair and dermatitis. |
| Choline | Rations low in methionine, an amino acid. | Essential in building and maintaining cell structure and in the transmission of nerve impulses. | Depressed growth, fatty and cirrhotic liver, and necrotic kidneys. |
| Niacin | | Constituent of coenzymes.<br>Hydrogen transport. | Loss of appetite, diarrhea, and emaciation. |
| Pyridoxine ($B_6$) | | Key constituent of cofactors involving amino acid and energy metabolism. | Depressed growth, acrodynia, convulsions, and paralysis. |

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Table 3-3
Vitamin Chart
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| Vitamin Requirements[1] Vitamin Content of Ration | Recommended Allowances[1] | | Practical Sources of the Vitamin | Comments |
|---|---|---|---|---|
| | Daily Nutrients Per Rabbit | Per Pound of Ration | | |
| Fat-soluble Vitamins<br>Variable according to age and production (see Table 26-1).<br>A | 23 mcg of carotene per pound of ration has been shown to prevent symptoms of vitamin A deficiency. | 500 IU | Stabilized vitamin A.<br>Green grass or legume. | Vitamin A is not synthesized in the cecum.<br>It is wasteful to feed more vitamin A than needed. Also, extremely high levels over extended periods may cause bone fragility, hyperostosis, and exfoliated epithelium. |
| D | No allowances have been recommended for vitamin D supplementation. | | Sun-cured hays.<br>Exposure to sunlight.<br>Commercially available supplements of either $D_2$ or $D_3$. | The vitamin D requirement is directly related to the Ca:P ratio and their respective levels. |
| *18 mg/lb for rabbits in production.<br>E | 0.5 mg/lb of body weight. | 25 IU | Stabilized vitamin E.<br>Germ or gum oils of plants.<br>Green plants and hays.<br>Cereals. | |
| *0.1 mg/lb for gestating does.<br>K | No allowances have been recommended for vitamin K supplementation. | | Synthetic vitamin K.<br>Green grass.<br>Well-cured hays. | Studies indicate that dietary vitamin K is required for reproduction but not growth. |
| Water-soluble Vitamins<br>Biotin | | | Widely distributed in nature. | Deficiencies are not associated with normal rations. |
| *0.5 g/lb for growing rabbit.<br>Choline | | 0.12% | Choline chloride. | |
| *82 mg/lb for growing rabbit.<br>Niacin | 5 mg/lb of body weight. | | Synthetic niacin.<br>Green alfalfa.<br>Certain oil meal and fermentation solubles. | Limited amounts of niacin can be synthesized from the amino acid tryptophan. Supplemental niacin in some cases can increase growth rate. |
| *18 mg/lb for growing rabbit. $(B_6)$ | 40 mcg | 0.5 mg | Carrots, potatoes, and greens. | |

[1] As used herein, the distinction between "vitamin requirements" and "recommended allowances" is as follows: In vitamin requirements, no margins of safety are included intentionally, whereas in recommended allowances, margins of safety are provided in order to compensate for variations in feed composition, environment, and possible losses during storage or processing. Where preceded by an asterisk, the vitamin requirements, allowances, and other facts presented herein were taken from *Nutrient Requirements of Rabbits*, 2nd rev. ed., NRC-National Academy of Sciences, 1977.

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Table 3-4
Nutrient Requirements of Rabbits

## Composition of Some Common Rabbit Feeds, Excluding Amino Acids

| Line No. | Scientific Name<br>Short Name<br>American Feed Control Name (AAFCO)<br>Canada Feeds Act Name (CFA)<br>Other Names | International Feed No.* | Dry Matter (%) | DE (kcal/kg) | TDN (%) | Protein Total (%) | Protein Dig (%) | Crude Fiber (%) | Ether Extract (%) | Nitrogen-Free Extract (%) | Ash (%) | Calcium (%) | Chlorine (%) | Copper (mg/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | As-Fed Basis and Dry Basis (Moisture Free) | | | | | | | | | | |
| 1 | ALFALFA. *Medicago sativa* | | | | | | | | | | | | | |
| 2 | —fresh | 2-00-196 | 24 | 620 | 14 | 4.9 | 3.5 | 6.5 | 0.8 | 10.1 | 2.2 | 0.45 | 0.11 | 2.8 |
| 3 | | | *100* | *2540* | *57* | *19.9* | *14.4* | *26.5* | *3.2* | *41.3* | *9.1* | *1.87* | *0.48* | *10.9* |
| 4 | —hay, s-c, early bloom | 1-00-059 | 89 | 2200 | 50 | 17.7 | 12.9 | 24.9 | 2.4 | 37.3 | 8.1 | 1.33 | — | 19.3 |
| 5 | | | *100* | *2470* | *56* | *19.9* | *14.3* | *28.0* | *2.7* | *41.8* | *9.0* | *1.49* | — | *21.7* |
| 6 | —hay, s-c, full bloom | 1-00-068 | 89 | 1780 | 40 | 13.3 | 9.1 | 30.6 | 1.6 | 35.5 | 7.8 | 1.13 | — | 10.31 |
| 7 | | | *100* | *2000* | *45* | *15.0* | *10.3* | *34.4* | *1.9* | *40.0* | *8.9* | *1.29* | — | *11.72* |
| 8 | —meal dehy, 17% protein | 1-00-023 | 92 | 2360 | 53 | 17.4 | 12.2 | 23.9 | 2.7 | 38.1 | 9.8 | 1.32 | 0.48 | 8.99 |
| 9 | | | *100* | *2560* | *58* | *18.9* | *13.3* | *26.0* | *2.9* | *41.3* | *10.6* | *1.44* | *0.52* | *9.77* |
| 10 | —meal dehy, 20% protein | 1-00-024 | 92 | 2610 | 59 | 20.2 | 15.0 | 20.3 | 3.2 | 37.4 | 10.4 | 1.53 | 0.47 | 8.40 |
| 11 | | | *100* | *2830* | *64* | *22.1* | *16.3* | *22.2* | *3.5* | *40.9* | *11.3* | *1.66* | *0.51* | *9.20* |
| 12 | BAKERY. | | | | | | | | | | | | | |
| 13 | —waste, dehy | 4-00-466 | 92 | 4150 | 101 | 9.8 | 9.4 | 1.0 | 11.5 | 65.1 | 4.5 | 0.20 | 0.90 | — |
| 14 | Dried Bakery Product (AAFCO) | | *100* | *4510* | *110* | *10.7* | *10.2* | *1.1* | *12.5* | *70.8* | *4.9* | *0.22* | *0.98* | — |
| 15 | BARLEY. *Hordeum vulgare* | | | | | | | | | | | | | |
| 16 | —grain | 4-00-549 | 89 | 3330 | 75 | 12.4 | 9.9 | 5.6 | 1.7 | 67.1 | 3.1 | 0.04 | 0.18 | 8.00 |
| 17 | | | *100* | *3740* | *84* | *13.9* | *11.1* | *6.3* | *1.9* | *75.2* | *3.5* | *0.05* | *0.20* | *8.99* |
| 18 | —grain, Pacific Coast | 4-07-939 | 89 | 3330 | 75 | 9.5 | 8.0 | 6.2 | 1.9 | 68.4 | 2.5 | 0.04 | 0.15 | 8.00 |
| 19 | | | *100* | *3740* | *84* | *10.7* | *9.0* | *7.0* | *2.2* | *76.9* | *2.8* | *0.05* | *0.17* | *8.99* |
| 20 | BEET, SUGAR. *Beta saccharifera* | | | | | | | | | | | | | |
| 21 | —pulp, dehy | 4-00-669 | 90 | 3080 | 70 | 8.6 | 4.1 | 18.3 | 0.5 | 58.4 | 4.7 | 0.65 | 0.04 | 12.38 |
| 22 | Dried Beet Pulp (CFA) | | *100* | *3420* | *78* | *9.5* | *4.6* | *20.2* | *0.6* | *64.7* | *5.2* | *0.72* | *0.04* | *13.76* |
| 23 | Dried Beet Pulp (AAFCO) | | | | | | | | | | | | | |
| 24 | BERMUDAGRASS. *Cynodon dactylon* | | | | | | | | | | | | | |
| 25 | —hay, s-c | 1-00-703 | 91 | 1880 | 43 | 7.5 | 4.0 | 26.0 | 1.8 | 49.0 | 7.0 | 0.37 | — | — |
| 26 | | | *100* | *2080* | *47* | *8.2* | *4.5* | *28.6* | *2.0* | *53.9* | *7.7* | *0.41* | — | — |
| 27 | BERMUDAGRASS, COASTAL. *Cynodon dactylon* | | | | | | | | | | | | | |
| 28 | —hay, s-c | 1-00-716 | 91 | 1770 | 40 | 11.1 | 5.7 | 27.6 | 2.1 | 46.5 | 5.7 | 0.36 | — | — |
| 29 | | | *100* | *1940* | *44* | *12.3* | *6.2* | *30.4* | *2.3* | *51.1* | *6.3* | *0.39* | — | — |
| 30 | CLOVER. *Trifolium pratense* | | | | | | | | | | | | | |
| 31 | —red, hay, s-c | 1-01-415 | 87 | 2170 | 49 | 14.1 | 9.8 | 25.5 | 2.4 | 38.1 | 7.5 | 1.30 | 0.28 | 9.48 |
| 32 | | | *100* | *2390* | *54* | *15.9* | *11.0* | *28.7* | *2.6* | *44.0* | *8.5* | *1.49* | *0.32* | *10.81* |
| 33 | CORN. *Zea mays* | | | | | | | | | | | | | |
| 34 | —gluten, meal | 5-02-900 | 91 | — | — | 42.9 | 31.5 | 4.6 | 2.1 | 39.4 | 3.1 | 0.15 | 0.07 | 28.30 |
| 35 | Corn Gluten Meal (CFA) | | *100* | — | — | *47.2* | *34.6* | *5.0* | *2.3* | *43.3* | *3.4* | *0.16* | *0.08* | *31.10* |
| 36 | Corn Gluten Meal (AAFCO) | | | | | | | | | | | | | |
| 37 | —grain, dent yellow | 4-02-935 | 89 | 3790 | 83 | 9.3 | 7.3 | 2.0 | 3.9 | 72.8 | 1.3 | 0.03 | 0.04 | 3.20 |
| 38 | | | *100* | *4260* | *93* | *10.5* | *8.3* | *2.2* | *4.4* | *82.1* | *1.5* | *0.03* | *0.05* | *3.60* |
| 39 | COTTON. *Gossypium* spp. | | | | | | | | | | | | | |
| 40 | —seeds, meal solv extd, 41% protein | 5-01-621 | 90 | 3080 | 67 | 40.7 | 34.5 | 12.6 | 2.1 | 31.8 | 6.2 | 0.17 | 0.05 | 20.48 |
| 41 | | | *100* | *3430* | *74* | *45.2* | *38.4* | *14.0* | *2.3* | *34.9* | *6.9* | *0.19* | *0.06* | *22.76* |
| 42 | DICALCIUM PHOSPHATE. | 6-01-080 | 97 | 0 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 79.2 | 23.00 | — | 8.01 |
| 43 | Dicalcium phosphate (AAFCO) | | *100* | *0* | *0* | *0.0* | *0.0* | *0.0* | *0.0* | *0.0* | *81.4* | *23.70* | — | *8.29* |
| 44 | FLAX. *Linum usitatissimum* | | | | | | | | | | | | | |
| 45 | —seeds, meal solv extd | 5-02-048 | 90 | 3430 | 68 | 35.0 | 30.4 | 8.9 | 1.6 | 38.4 | 5.7 | 0.38 | 0.04 | 25.80 |
| 46 | Solvent-Extracted Linseed Meal (CFA) | | *100* | *3810* | *75* | *38.9* | *33.9* | *9.9* | *1.8* | *42.8* | *6.4* | *0.43* | *0.04* | *28.64* |
| 47 | Linseed Meal, Solvent Extracted (AAFCO) | | | | | | | | | | | | | |
| 48 | MILK. | | | | | | | | | | | | | |
| 49 | —dehy | 5-01-167 | 96 | 5180 | 118 | 25.2 | 25.4 | 0.2 | 26.7 | 38.3 | 5.6 | 0.91 | 1.49 | 0.91 |
| 50 | Dried whole milk, feed grade (AAFCO) | | *100* | *5390* | *123* | *26.3* | *26.4* | *0.2* | *27.8* | *39.7* | *5.8* | *0.95* | *1.55* | *0.94* |
| 51 | —skimmed dehy | 5-01-175 | 94 | — | — | 33.6 | 32.9 | 0.3 | 0.9 | 51.1 | 8.0 | 1.28 | 0.90 | 11.66 |
| 52 | Dried skimmed milk, feed grade (AAFCO) | | *100* | — | — | *35.7* | *35.2* | *0.3* | *0.9* | *54.6* | *8.6* | *1.37* | *0.96* | *12.41* |

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## Table 3-4
## Nutrient Requirements of Rabbits
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As-Fed Basis and Dry Basis (Moisture Free)

| Line No. | Iodine (mg/kg) | Iron (%) | Magnesium (%) | Manganese (mg/kg) | Phosphorus (%) | Sodium (%) | Sulfur (%) | Zinc (mg/kg) | Biotin (mg/kg) | Choline (mg/kg) | Folic Acid (mg/kg) | Niacin (mg/kg) | Pantothenic Acid (mg/kg) | Provitamin A (Carotene) (mg/kg) | Vitamin B$_6$ (mg/kg) | Riboflavin (mg/kg) | Thiamin (mg/kg) | Vitamin E (mg/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | | | | | | | | |
| 2 | — | 0.012 | 0.05 | 15.1 | 0.06 | 0.05 | 0.10 | 4.2 | 0.12 | 373 | — | 11.8 | 8.7 | 46.6 | 1.60 | 3.2 | 1.4 | 146 |
| 3 | — | *0.049* | *0.20* | *62.9* | *0.25* | *0.19* | *0.41* | *17.6* | *0.49* | *1556* | — | *49.1* | *36.4* | *194.0* | *6.68* | *13.4* | *5.9* | *608* |
| 4 | — | 0.018 | 0.29 | 27.5 | 0.23 | 0.14 | 0.25 | 15.3 | — | — | — | — | — | — | — | — | — | — |
| 5 | — | *0.020* | *0.33* | *30.9* | *0.26* | *0.15* | *0.28* | *17.2* | — | — | — | — | — | — | — | — | — | — |
| 6 | — | 0.015 | 0.27 | 32.1 | 0.20 | 0.04 | 0.23 | 21.1 | — | — | — | — | — | 10.6 | — | — | — | — |
| 7 | — | *0.017* | *0.31* | *36.5* | *0.23* | *0.04* | *0.26* | *24.0* | — | — | — | — | — | *12.0* | — | — | — | — |
| 8 | 0.149 | 0.042 | 0.29 | 30.8 | 0.24 | 0.12 | 0.24 | 19.4 | 0.30 | 1401 | 2.07 | 39.3 | 29.3 | 120.6 | 8.00 | 13.3 | 3.4 | 124 |
| 9 | *0.161* | *0.046* | *0.32* | *33.5* | *0.26* | *0.13* | *0.26* | *21.1* | *0.33* | *1523* | *2.25* | *42.7* | *31.8* | *131.1* | *8.70* | *14.4* | *3.7* | *135* |
| 10 | 0.137 | 0.037 | 0.34 | 33.4 | 0.27 | 0.11 | 0.42 | 22.9 | 0.33 | 1446 | 2.64 | 49.1 | 35.3 | 151.3 | 9.30 | 14.3 | 5.3 | 145 |
| 11 | *0.150* | *0.040* | *0.37* | *36.5* | *0.30* | *0.12* | *0.46* | *25.0* | *0.36* | *1582* | *2.87* | *53.7* | *38.7* | *165.6* | *10.17* | *15.6* | *5.8* | *158* |
| 12 | | | | | | | | | | | | | | | | | | |
| 13 | — | 0.006 | 0.32 | 35.1 | 0.41 | 0.60 | 0.02 | 15.0 | 0.07 | 1165 | 0.15 | 26.2 | 21.5 | 4.6 | 30.99 | 1.1 | 1.5 | 219 |
| 14 | — | *0.007* | *0.35* | *38.2* | *0.44* | *0.66* | *0.02* | *16.4* | *0.08* | *1268* | *0.16* | *28.5* | *23.3* | *5.0* | *33.72* | *1.2* | *1.6* | *238* |
| 15 | | | | | | | | | | | | | | | | | | |
| 16 | 0.050 | 0.008 | 0.13 | 16.3 | 0.33 | 0.03 | 0.16 | 15.2 | 0.14 | 913 | 0.53 | 75.2 | 7.4 | 2.5 | 6.27 | 1.4 | 3.9 | 14 |
| 17 | *0.056* | *0.009* | *0.15* | *18.6* | *0.37* | *0.03* | *0.18* | *17.0* | *0.16* | *1026* | *0.60* | *84.5* | *8.3* | *2.8* | *7.04* | *1.6* | *4.4* | *16* |
| 18 | — | 0.011 | 0.12 | 16.2 | 0.34 | 0.02 | 0.15 | 15.2 | 0.15 | 991 | 0.50 | 47.4 | 7.9 | — | 2.90 | 1.5 | 4.2 | 21 |
| 19 | — | *0.012* | *0.13* | *18.3* | *0.38* | *0.02* | *0.17* | *17.1* | *0.17* | *1114* | *0.56* | *53.3* | *8.9* | — | *3.26* | *1.7* | *4.7* | *24* |
| 20 | | | | | | | | | | | | | | | | | | |
| 21 | — | 0.030 | 0.27 | 34.5 | 0.09 | 0.21 | 0.20 | 0.7 | — | 810 | — | 16.7 | 1.4 | 0.2 | — | 0.7 | 0.4 | — |
| 22 | — | *0.033* | *0.30* | *38.3* | *0.10* | *0.23* | *0.22* | *0.8* | — | *900* | — | *18.5* | *1.5* | *0.2* | — | *0.8* | *0.4* | — |
| 23 | | | | | | | | | | | | | | | | | | |
| 24 | | | | | | | | | | | | | | | | | | |
| 25 | 0.104 | — | 0.15 | — | 0.19 | — | — | — | — | — | — | — | — | 73.9 | — | — | — | — |
| 26 | *0.115* | — | *0.17* | — | *0.21* | — | — | — | — | — | — | — | — | *81.3* | — | — | — | — |
| 27 | | | | | | | | | | | | | | | | | | |
| 28 | — | — | 0.15 | — | 0.17 | — | — | 0.9 | — | — | — | — | — | 74.3 | — | — | — | — |
| 29 | — | — | *0.17* | — | *0.19* | — | — | *1.0* | — | — | — | — | — | *81.7* | — | — | — | — |
| 30 | | | | | | | | | | | | | | | | | | |
| 31 | — | 0.018 | 0.37 | 63.8 | 0.22 | 0.16 | 0.15 | — | 0.10 | — | — | 37.0 | 9.7 | 23.9 | — | 15.5 | 1.9 | — |
| 32 | — | *0.021* | *0.43* | *73.3* | *0.25* | *0.18* | *0.17* | — | *0.11* | — | — | *42.6* | *11.2* | *27.5* | — | *17.8* | *2.2* | — |
| 33 | | | | | | | | | | | | | | | | | | |
| 34 | — | 0.039 | 0.05 | 7.3 | 0.46 | 0.08 | 0.36 | — | 0.17 | 369 | 0.34 | 50.0 | 9.8 | 16.3 | 7.89 | 1.5 | 0.2 | 34 |
| 35 | — | *0.043* | *0.06* | *8.0* | *0.51* | *0.09* | *0.40* | — | *0.19* | *405* | *0.37* | *55.0* | *10.8* | *17.9* | *8.77* | *1.6* | *0.2* | *37* |
| 36 | | | | | | | | | | | | | | | | | | |
| 37 | 0.052 | 0.003 | 0.12 | 5.0 | 0.28 | 0.01 | 0.12 | 10.0 | 0.06 | 542 | 0.36 | 30.4 | 6.7 | 2.2 | 5.24 | 1.3 | 2.0 | 23 |
| 38 | *0.059* | *0.003* | *0.14* | *5.6* | *0.31* | *0.01* | *0.14* | *11.2* | *0.07* | *609* | *0.40* | *34.2* | *7.5* | *2.5* | *5.89* | *1.5* | *2.3* | *26* |
| 39 | | | | | | | | | | | | | | | | | | |
| 40 | — | 0.022 | 0.56 | 20.5 | 1.09 | 0.04 | 0.21 | 60.0 | 0.59 | 2752 | 2.79 | 40.8 | 13.9 | — | 6.29 | 4.8 | 6.2 | 14 |
| 41 | — | *0.024* | *0.62* | *22.8* | *1.21* | *0.05* | *0.23* | *66.0* | *0.66* | *3058* | *3.08* | *45.1* | *15.4* | — | *6.99* | *5.3* | *6.9* | *16* |
| 42 | — | 0.128 | 0.60 | 148.6 | 18.27 | 2.63 | — | 26.8 | 0.0 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 |
| 43 | — | *0.132* | *0.62* | *153.2* | *18.84* | *2.71* | — | *27.6* | *0.0* | *0* | *0.0* | *0.0* | *0.0* | *0.0* | *0.0* | *0.0* | *0.0* | *0* |
| 44 | | | | | | | | | | | | | | | | | | |
| 45 | — | 0.032 | 0.60 | 37.5 | 0.81 | 0.14 | 0.40 | — | — | 1355 | — | 29.1 | 14.8 | — | — | 2.8 | 7.7 | 16 |
| 46 | — | *0.035* | *0.67* | *41.8* | *0.90* | *0.15* | *0.44* | — | — | *1506* | — | *32.4* | *16.4* | — | — | *3.1* | *8.6* | *18* |
| 47 | | | | | | | | | | | | | | | | | | |
| 48 | | | | | | | | | | | | | | | | | | |
| 49 | — | 0.017 | — | 0.5 | 0.73 | 0.36 | — | — | 0.38 | — | — | 8.4 | 22.8 | 7.1 | 4.74 | 19.8 | 3.7 | — |
| 50 | — | *0.018* | — | *0.5* | *0.76* | *0.38* | — | — | *0.40* | — | — | *8.8* | *23.8* | *7.4* | *4.94* | *20.6* | *3.9* | — |
| 51 | — | 0.005 | 0.12 | 2.2 | 1.02 | 0.35 | 0.32 | 41.0 | 0.33 | 1391 | 0.47 | 11.5 | 36.9 | — | 4.25 | 19.2 | 3.8 | 9 |
| 52 | — | *0.005* | *0.13* | *2.3* | *1.09* | *0.37* | *0.34* | *43.6* | *0.35* | *1480* | *0.50* | *12.2* | *39.3* | — | *4.52* | *20.4* | *4.0* | *10* |

From: Nutrient Requirements of Rabbits, Second revised edition, 1977,
Research Council, National Academy of Sciences Press.

Table 3-4
Nutrient Requirements of Rabbits
Page 3

| | | | | As-Fed Basis and Dry Basis (Moisture Free) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Protein | | | | | | | | |
| Line No. | Scientific Name<br>Short Name<br>American Feed Control Name (AAFCO)<br>Canada Feeds Act Name (CFA)<br>Other Names | International Feed No.* | Dry Matter (%) | DE (kcal/kg) | TDN (%) | Total (%) | Dig (%) | Crude Fiber (%) | Ether Extract (%) | Nitrogen-Free Extract (%) | Ash (%) | Calcium (%) | Chlorine (%) | Copper (mg/kg) |
| 53 | MOLASSES. | | | | | | | | | | | | | |
| 54 | —sugarcane. *Saccharum officinarum* | 4-04-696 | 75 | — | — | 3.9 | 2.0 | — | 0.1 | 63.7 | 7.4 | 0.79 | 2.78 | 60.38 |
| 55 | Cane Molasses (AAFCO) | | *100* | — | — | *5.2* | *2.7* | — | *0.1* | *84.9* | *9.8* | *1.05* | *3.71* | *80.51* |
| 56 | OATS. *Avena sativa* | | | | | | | | | | | | | |
| 57 | —grain | 4-03-309 | 89 | 2950 | 65 | 12.1 | 9.2 | 10.6 | 4.5 | 58.7 | 3.4 | 0.06 | 0.11 | 6.3 |
| 58 | | | *100* | *3310* | *73* | *13.6* | *10.4* | *11.9* | *5.1* | *66.0* | *3.8* | *0.07* | *0.12* | *7.15* |
| 59 | PEANUT. *Arachis hypogaea* | | | | | | | | | | | | | |
| 60 | —kernels, meal solv extd | 5-03-650 | 92 | 4120 | 90 | 49.9 | 45.2 | 10.5 | 2.4 | 28.5 | — | 0.20 | 0.03 | 15.26 |
| 61 | Solvent-Extracted Peanut Meal (AAFCO) | | *100* | *4480* | *98* | *54.2* | *49.2* | *11.3* | *2.6* | *31.1* | — | *0.22* | *0.03* | *16.59* |
| 62 | PHOSPHATE. | | | | | | | | | | | | | |
| 63 | —defluorinated grnd | 6-01-780 | 100 | 0 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — | 31.65 | — | 66.16 |
| 64 | Phosphate, Defluorinated (AAFCO) | | *100* | *0* | *0* | *0.0* | *0.0* | *0.0* | *0.0* | *0.0* | — | *31.65* | — | *66.16* |
| 65 | RYE. *Secale cereale* | | | | | | | | | | | | | |
| 66 | —grain | 4-04-047 | 88 | 3590 | 77 | 12.1 | 9.0 | 2.3 | 1.6 | 74.5 | 1.7 | 0.06 | 0.03 | 6.75 |
| 67 | | | *100* | *4080* | *88* | *13.8* | *10.7* | *2.6* | *1.8* | *81.0* | *1.9* | *0.07* | *0.03* | *7.67* |
| 68 | SORGHUM. *Sorghum vulgare* | | | | | | | | | | | | | |
| 69 | —grain | 4-04-383 | 89 | 3330 | — | 10.7 | 6.4 | 2.2 | 3.1 | 72.0 | 2.1 | 0.04 | 0.09 | 9.65 |
| 70 | | | *100* | *3745* | — | *12.0* | *7.2* | *2.4* | *3.5* | *81.5* | *2.4* | *0.04* | *0.10* | *10.84* |
| 71 | SOYBEAN. *Glycine max* | | | | | | | | | | | | | |
| 72 | —seeds, meal solv extd | 5-04-604 | 89 | 3770 | 82 | 46.1 | 41.4 | 5.8 | 1.0 | 30.8 | 5.9 | 0.28 | 0.03 | 27.30 |
| 73 | Soybean Meal, Solvent Extracted (AAFCO) | | *100* | *4240* | *92* | *51.8* | *46.5* | *6.5* | *1.1* | *34.6* | *6.6* | *0.31* | *0.03* | *30.67* |
| 74 | —seeds wo hulls, meal solv extd | 5-04-612 | 90 | — | — | 50.2 | 45.0 | 3.0 | 0.9 | 30.4 | 5.8 | 0.24 | 0.05 | 21.70 |
| 75 | Soybean Meal, Dehulled, Solvent Extracted | | *100* | — | — | *55.6* | *49.8* | *3.3* | *1.0* | *33.7* | *6.4* | *0.27* | *0.05* | *24.15* |
| 76 | (AAFCO) | | | | | | | | | | | | | |
| 77 | SUNFLOWER. *Helianthus* spp. | | | | | | | | | | | | | |
| 78 | —seeds wo hulls, meal solv extd | 5-04-739 | 93 | — | — | 46.3 | 41.2 | 11.0 | 2.9 | 24.8 | 7.7 | 0.38 | 0.10 | 3.50 |
| 79 | Sunflower Meal, Dehulled, Solvent Extracted | | *100* | — | — | *49.8* | *44.4* | *11.8* | *3.1* | *26.7* | *8.3* | *0.41* | *0.11* | *3.77* |
| 80 | (AAFCO) | | | | | | | | | | | | | |
| 81 | TIMOTHY. *Phleum pratense* | | | | | | | | | | | | | |
| 82 | —hay, s-c, midbloom | 1-04-883 | 88 | 1420 | 32 | 8.4 | 4.9 | 30.0 | 2.2 | 40.0 | 6.0 | 0.36 | — | 4.46 |
| 83 | | | *100* | *1600* | *36* | *9.5* | *5.6* | *34.1* | *2.5* | *45.4* | *6.9* | *0.41* | — | *5.07* |
| 84 | WHEAT. *Triticum* spp. | | | | | | | | | | | | | |
| 85 | —bran | 4-05-190 | 89 | 2610 | 57 | 15.1 | 12.8 | 10.3 | 4.2 | 53.8 | 5.9 | 0.11 | 0.05 | 12.78 |
| 86 | Bran (CFA) | | *100* | *2930* | *64* | *17.0* | *14.4* | *11.7* | *4.8* | *60.7* | *6.7* | *0.12* | *0.06* | *14.36* |
| 87 | Wheat Bran (AAFCO) | | | | | | | | | | | | | |
| 88 | —grain, hard red spring | 4-05-258 | 89 | 3680 | 79 | 15.6 | 9.2 | 2.6 | 2.0 | 69.1 | 1.7 | 0.04 | 0.08 | 6.39 |
| 89 | | | *100* | *4130* | *89* | *17.5* | *10.3* | *3.0* | *2.3* | *77.7* | *1.9* | *0.04* | *0.09* | *7.18* |
| 90 | —grain, hard red winter | 4-05-268 | 89 | 3680 | 84 | 12.8 | 9.0 | 2.4 | 2.0 | 69.4 | 1.7 | 0.04 | 0.05 | 4.79 |
| 91 | | | *100* | *4130* | *94* | *14.4* | *10.2* | *2.7* | *2.3* | *78.2* | *1.9* | *0.05* | *0.06* | *5.38* |
| 92 | —grain, soft white winter | 4-05-337 | 88 | 3680 | 79 | 9.8 | 8.6 | 2.7 | 1.7 | 71.2 | 2.0 | 0.05 | 0.08 | 6.90 |
| 93 | | | *100* | *4130* | *90* | *11.1* | *9.8* | *3.0* | *2.0* | *81.1* | *2.3* | *0.06* | *0.09* | *7.84* |

* The first digit is the feed class: (1) dry forages and roughages; (2) pasture, range plants, and forages fed green; (3) silages; (4) energy feeds; (5) protein supplements; (6) minerals; (7) vitamins; (8) additives.

From: Nutrient Requirements of Rabbits, Second revised edition, 1977, The Research Council, National Academy of Sciences Press.

Table 3-4
Nutrient Requirements of Rabbits
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As-Fed Basis and Dry Basis (Moisture Free)

| Line No. | Iodine (mg/kg) | Iron (%) | Magnesium (%) | Manganese (mg/kg) | Phosphorus (%) | Sodium (%) | Sulfur (%) | Zinc (mg/kg) | Biotin (mg/kg) | Choline (mg/kg) | Folic Acid (mg/kg) | Niacin (mg/kg) | Pantothenic Acid (mg/kg) | Provitamin A (Carotene) (mg/kg) | Vitamin $B_6$ (mg/kg) | Riboflavin (mg/kg) | Thiamin (mg/kg) | Vitamin E (mg/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 53 | | | | | | | | | | | | | | | | | | |
| 54 | — | 0.020 | 0.35 | 42.8 | 0.08 | 0.16 | 0.34 | 22.5 | 0.70 | 744 | 0.11 | 40.6 | 39.2 | — | 6.50 | 2.8 | 0.9 | 5 |
| 55 | — | *0.026* | *0.47* | *57.1* | *0.11* | *0.22* | *0.46* | *30.0* | *0.94* | *992* | *0.15* | *54.2* | *52.2* | — | *8.67* | *3.8* | *1.2* | *7* |
| 56 | | | | | | | | | | | | | | | | | | |
| 57 | — | 0.008 | 0.12 | 37.4 | 0.33 | 0.16 | 0.21 | — | 0.24 | 1013 | 0.30 | 13.7 | 7.4 | 0.1 | 2.53 | 1.5 | 6.3 | 12 |
| 58 | — | *0.009* | *0.14* | *42.0* | *0.37* | *0.18* | *0.23* | — | *0.27* | *1138* | *0.33* | *15.4* | *8.3* | *0.1* | *2.84* | *1.7* | *7.1* | *14* |
| 59 | | | | | | | | | | | | | | | | | | |
| 60 | — | — | 0.04 | 26.9 | 0.63 | 0.41 | — | 32.8 | 0.32 | 1898 | 0.40 | 166.3 | 48.5 | — | 5.28 | 10.6 | 5.5 | 3 |
| 61 | — | — | *0.04* | *29.2* | *0.69* | *0.45* | — | *35.6* | *0.36* | *2133* | *0.44* | *186.8* | *54.5* | — | *5.93* | *11.9* | *6.2* | *3* |
| 62 | | | | | | | | | | | | | | | | | | |
| 63 | — | 0.709 | 0.27 | 696.4 | 13.70 | 0.19 | 0.13 | 74.0 | 0.0 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 |
| 64 | — | *0.709* | *0.27* | *696.4* | *13.70* | *0.19* | *0.13* | *74.0* | *0.0* | *0* | *0.0* | *0.0* | *0.0* | *0.0* | *0.0* | *0.0* | *0.0* | *0* |
| 65 | | | | | | | | | | | | | | | | | | |
| 66 | — | 0.006 | 0.36 | 55.0 | 0.32 | 0.03 | 0.15 | 31.8 | 0.33 | — | 0.62 | 20.5 | 9.0 | 10.2 | 2.59 | 1.6 | 3.0 | 15 |
| 67 | — | *0.007* | *0.41* | *62.5* | *0.36* | *0.03* | *0.17* | *36.1* | *0.37* | — | *0.70* | *23.3* | *10.2* | *11.6* | *2.94* | *1.8* | *3.4* | *17* |
| 68 | | | | | | | | | | | | | | | | | | |
| 69 | — | 0.004 | 0.18 | 15.4 | 0.29 | 0.03 | 0.14 | 14.3 | 0.41 | 622 | 0.20 | 40.8 | 11.2 | 1.2 | 4.62 | 1.2 | 4.2 | 11 |
| 70 | — | *0.005* | *0.20* | *17.3* | *0.33* | *0.03* | *0.16* | *16.1* | *0.46* | *699* | *0.23* | *45.8* | *12.6* | *1.3* | *5.19* | *1.4* | *4.7* | *12* |
| 71 | | | | | | | | | | | | | | | | | | |
| 72 | — | 0.012 | 0.27 | 28.4 | 0.62 | 0.28 | 0.43 | 42.6 | 0.23 | 2630 | 0.45 | 27.5 | 16.0 | 0.2 | 6.39 | 2.9 | 5.5 | 2 |
| 73 | — | *0.013* | *0.30* | *31.9* | *0.70* | *0.31* | *0.48* | *47.9* | *0.36* | *2955* | *0.50* | *30.9* | *18.0* | *0.2* | *7.18* | *3.3* | *6.2* | *2* |
| 74 | — | — | — | 27.8 | 0.62 | 0.26 | 0.43 | 45.3 | 0.32 | 2757 | 0.70 | 21.7 | 14.6 | — | 8.00 | 3.1 | 2.2 | 3 |
| 75 | — | — | — | *30.8* | *0.69* | *0.28* | *0.48* | *50.1* | *0.36* | *3053* | *0.78* | *24.0* | *16.2* | — | *8.86* | *3.4* | *2.4* | *4* |
| 76 | | | | | | | | | | | | | | | | | | |
| 77 | | | | | | | | | | | | | | | | | | |
| 78 | — | 0.003 | 0.73 | 14.4 | 1.05 | 1.21 | — | — | — | 3596 | — | 225.2 | 24.8 | — | 15.98 | 4.2 | — | 11 |
| 79 | — | *0.004* | *0.78* | *15.5* | *1.13* | *1.30* | — | — | — | *3870* | — | *274.4* | *26.7* | — | *17.20* | *4.5* | — | *12* |
| 80 | | | | | | | | | | | | | | | | | | |
| 81 | | | | | | | | | | | | | | | | | | |
| 82 | — | 0.012 | 0.14 | 40.7 | 0.17 | 0.16 | 0.11 | — | — | — | — | — | — | 47.0 | — | — | — | — |
| 83 | — | *0.014* | *0.16* | *46.3* | *0.19* | *0.18* | *0.13* | — | — | — | — | — | — | *53.4* | — | — | — | — |
| 84 | | | | | | | | | | | | | | | | | | |
| 85 | 0.074 | 0.011 | 0.52 | 110.6 | 1.26 | 0.04 | 0.22 | 109.8 | 0.57 | 1865 | 1.21 | 273.1 | 47.9 | 2.6 | 10.56 | 4.8 | 6.6 | 21 |
| 86 | *0.083* | *0.012* | *0.58* | *124.3* | *1.42* | *0.04* | *0.25* | *123.9* | *0.64* | *2095* | *1.37* | *306.8* | *53.8* | *2.9* | *11.85* | *5.4* | *7.4* | *24* |
| 87 | | | | | | | | | | | | | | | | | | |
| 88 | — | 0.006 | 0.16 | 37.4 | 0.38 | 0.03 | — | 26.3 | 0.12 | 854 | 0.41 | 57.8 | 10.1 | 10.3 | 5.14 | 1.4 | 4.3 | 12.8 |
| 89 | — | *0.007* | *0.18* | *42.0* | *0.43* | *0.03* | — | *29.6* | *0.13* | *960* | *0.46* | *64.9* | *11.3* | *11.6* | *5.78* | *1.6* | *4.8* | *14.4* |
| 90 | — | 0.004 | 0.10 | 29.3 | 0.38 | 0.02 | 0.15 | 30.6 | 0.11 | 1046 | 0.37 | 54.2 | 10.0 | — | 3.03 | 1.5 | 4.3 | 11.1 |
| 91 | — | *0.004* | *0.12* | *32.9* | *0.43* | *0.02* | *0.17* | *34.5* | *0.12* | *1175* | *0.42* | *60.9* | *11.2* | — | *3.40* | *1.7* | *4.8* | *12.5* |
| 92 | — | 0.004 | 0.10 | 38.1 | 0.32 | 0.03 | — | 27.8 | 0.11 | 967 | 0.38 | 35.4 | 11.1 | — | 4.07 | 1.2 | 4.7 | 13.7 |
| 93 | — | *0.004* | *0.11* | *43.3* | *0.36* | *0.03* | — | *31.6* | *0.12* | *1099* | *0.41* | *40.2* | *12.6* | — | *4.62* | *1.4* | *5.3* | *15.6* |

From: Nutrient Requirements of Rabbits, Second revised edition, 1977, The Research Council, National Academy of Sciences Press.

Table 3-5
Amino Acids
Nutrient Requirements of Rabbits

## Amino Acid Composition of Some Common Rabbit Feed Ingredients

| Line No. | Scientific Name<br>Short Name<br>American Feed Control Name (AAFCO)<br>Canada Feeds Act Name (CFA)<br>Other Names | International Feed No.[a] | Dry Matter (%) | As-Fed Basis and Dry Basis (Moisture Free) Arginine (%) | Cystine (%) | Histidine (%) | Isoleucine (%) | Leucine (%) | Lysine (%) | Methionine (%) | Phenylalanine (%) | Threonine (%) | Tryptophan (%) | Tyrosine (%) | Valine (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ALFALFA. *Medicago sativa* | | | | | | | | | | | | | | |
| 2 | —fresh | 2-00-196 | 24 | — | — | — | — | — | — | — | — | — | — | — | — |
| 3 | | | *100* | — | — | — | — | — | — | — | — | — | — | — | — |
| 4 | —hay, s-c, early bloom | 1-00-059 | 89 | 0.80 | 0.32 | 0.24 | 0.72 | 1.13 | 0.89 | 0.16 | 0.71 | 0.63 | 0.24 | 0.48 | 0.72 |
| 5 | | | *100* | *0.90* | *0.36* | *0.28* | *0.81* | *1.27* | *1.00* | *0.18* | *0.80* | *0.71* | *0.27* | *0.54* | *0.81* |
| 6 | —hay, s-c, full bloom | 1-00-068 | 88 | 0.62 | 0.03 | 0.26 | 0.66 | 0.89 | 0.54 | 0.09 | — | 0.62 | 0.09 | — | 0.62 |
| 7 | | | *100* | *0.71* | *0.03* | *0.30* | *0.81* | *1.01* | *0.61* | *0.10* | — | *0.71* | *0.10* | — | *0.71* |
| 8 | —meal dehy, 17% protein | 1-00-023 | 92 | 0.76 | 0.30 | 0.32 | 0.82 | 1.27 | 0.90 | 0.21 | 0.79 | 0.68 | 0.35 | 0.56 | 0.83 |
| 9 | | | *100* | *0.82* | *0.32* | *0.34* | *0.89* | *1.37* | *0.97* | *0.23* | *0.86* | *0.74* | *0.38* | *0.60* | *0.90* |
| 10 | —meal dehy, 20% protein | 1-00-024 | 92 | 0.95 | 0.31 | 0.34 | 0.87 | 1.37 | 0.90 | 0.32 | 0.86 | 0.74 | 0.43 | 0.61 | 0.97 |
| 11 | | | *100* | *1.04* | *0.34* | *0.37* | *0.95* | *1.50* | *0.98* | *0.35* | *0.94* | *0.81* | *0.47* | *0.67* | *1.06* |
| 12 | BAKERY. | | | | | | | | | | | | | | |
| 13 | —waste, dehy | 4-00-466 | 92 | 0.51 | 0.18 | 0.15 | 0.36 | 0.70 | 0.32 | 0.17 | 0.40 | 0.44 | 0.10 | 0.30 | 0.40 |
| 14 | Dried Bakery Product (AAFCO) | | *100* | *0.55* | *0.19* | *0.16* | *0.39* | *0.76* | *0.35* | *0.19* | *0.44* | *0.48* | *0.11* | *0.33* | *0.44* |
| 15 | BARLEY. *Hordeum vulgare* | | | | | | | | | | | | | | |
| 16 | —grain | 4-00-549 | 89 | 0.55 | 0.21 | 0.26 | 0.51 | 0.82 | 0.46 | 0.18 | 0.61 | 0.38 | 0.16 | 0.36 | 0.62 |
| 17 | | | *100* | *0.62* | *0.23* | *0.29* | *0.57* | *0.92* | *0.51* | *0.20* | *0.69* | *0.43* | *0.18* | *0.40* | *0.6* |
| 18 | —grain, Pacific Coast | 4-07-939 | 89 | 0.44 | 0.20 | 0.21 | 0.40 | 0.60 | 0.27 | 0.14 | 0.48 | 0.29 | 0.12 | — | 0.46 |
| 19 | | | *100* | *0.49* | *0.22* | *0.24* | *0.45* | *0.67* | *0.30* | *0.16* | *0.54* | *0.33* | *0.14* | — | *0.52* |
| 20 | BEET, SUGAR. *Beta saccharifera* | | | | | | | | | | | | | | |
| 21 | —pulp, dehy | 4-00-669 | 90 | 0.30 | — | 0.20 | 0.30 | 0.60 | 0.59 | 0.01 | 0.30 | 0.40 | 0.10 | 0.40 | 0.40 |
| 22 | Dried Beet Pulp (CFA) | | *100* | *0.33* | — | *0.22* | *0.33* | *0.66* | *0.66* | *0.01* | *0.33* | *0.44* | *0.11* | *0.44* | *0.44* |
| 23 | Dried Beet Pulp (AAFCO) | | | | | | | | | | | | | | |
| 24 | BERMUDAGRASS. *Cynodon dactylon* | | | | | | | | | | | | | | |
| 25 | —hay, s-c | 1-00-703 | 91 | — | — | — | — | — | — | — | — | — | — | — | — |
| 26 | | | *100* | — | — | — | — | — | — | — | — | — | — | — | — |
| 27 | BERMUDAGRASS, COASTAL. *Cynodon dactylon* | | | | | | | | | | | | | | |
| 28 | —hay, s-c | 1-00-716 | 91 | — | — | — | — | — | — | — | — | — | — | — | — |
| 29 | | | *100* | — | — | — | — | — | — | — | — | — | — | — | — |
| 30 | CLOVER. *Trifolium pratense* | | | | | | | | | | | | | | |
| 31 | —red, hay, s-c | 1-01-415 | 87 | — | — | — | — | — | — | — | — | — | — | — | — |
| 32 | | | *100* | — | — | — | — | — | — | — | — | — | — | — | — |
| 33 | CORN. *Zea mays* | | | | | | | | | | | | | | |
| 34 | —gluten, meal | 5-02-900 | 91 | 1.42 | 0.66 | 0.96 | 2.21 | 7.33 | 0.83 | 1.07 | 2.78 | 1.43 | 0.21 | 1.00 | 2.24 |
| 35 | Corn Gluten Meal (CFA) | | *100* | *1.56* | *0.73* | *1.06* | *2.43* | *8.05* | *0.91* | *1.18* | *3.06* | *1.57* | *0.23* | *1.10* | *2.46* |
| 36 | Corn Gluten Meal (AAFCO) | | | | | | | | | | | | | | |
| 37 | —grain, dent yellow | 4-02-935 | 89 | 0.50 | 0.13 | 0.20 | 0.40 | 1.10 | 0.20 | 0.13 | 0.50 | 0.40 | 0.09 | 0.44 | 0.37 |
| 38 | | | *100* | *0.56* | *0.15* | *0.22* | *0.45* | *1.24* | *0.22* | *0.15* | *0.56* | *0.45* | *0.11* | *0.50* | *0.42* |
| 39 | COTTON. *Gossypium* spp. | | | | | | | | | | | | | | |
| 40 | —seeds, meal solv extd, 41% protein | 5-01-621 | 90 | 4.36 | 0.67 | 1.02 | 1.20 | 2.17 | 1.59 | 0.49 | 2.00 | 1.21 | 0.48 | 1.06 | 1.64 |
| 41 | | | *100* | *4.79* | *0.73* | *1.12* | *1.32* | *2.38* | *1.74* | *0.54* | *2.20* | *1.33* | *0.53* | *1.16* | *1.80* |
| 42 | DICALCIUM PHOSPHATE. | 6-01-080 | 97 | — | — | — | — | — | — | — | — | — | — | — | — |
| 43 | Dicalcium phosphate (AAFCO) | | *100* | — | — | — | — | — | — | — | — | — | — | — | — |
| 44 | FLAX. *Linum usitatissimum* | | | | | | | | | | | | | | |
| 45 | —seeds, meal solv extd | 5-02-048 | 90 | 3.05 | 0.62 | 0.68 | 1.74 | 2.16 | 1.20 | 0.57 | 1.58 | 1.29 | 0.53 | — | 1.82 |
| 46 | Solvent-Extracted Linseed Meal (CFA) | | *100* | *3.40* | *0.69* | *0.76* | *1.94* | *2.41* | *1.34* | *0.64* | *1.76* | *1.44* | *0.59* | — | *2.0* |
| 47 | Linseed Meal, Solvent Extracted (AAFCO) | | | | | | | | | | | | | | |

From: Nutrient Requirements of Rabbits, Second revised edition, 1977, The Research Council, National Academy of Sciences Press.

## Amino Acid Composition of Some Common Rabbit Feed Ingredients—Continued

| Line No. | Scientific Name<br>Short Name<br>American Feed Control Name (AAFCO)<br>Canada Feeds Act Name (CFA)<br>Other Names | International Feed No.ª | Dry Matter (%) | As-Fed Basis and Dry Basis (Moisture Free) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Arginine (%) | Cystine (%) | Histidine (%) | Isoleucine (%) | Leucine (%) | Lysine (%) | Methionine (%) | Phenylalanine (%) | Threonine (%) | Tryptophan (%) | Tyrosine (%) | Valine (%) |
| 48 | MILK. | | | | | | | | | | | | | | |
| 49 | —dehy | 5-01-167 | 96 | 0.92 | — | 0.72 | 1.34 | 2.57 | 2.26 | 0.62 | 1.34 | 1.03 | 0.41 | 1.34 | 1.76 |
| 50 | Dried Whole Milk, Feed Grade (AAFCO) | | *100* | *0.96* | — | *0.75* | *1.39* | *2.67* | *2.35* | *0.64* | *1.39* | *1.07* | *0.43* | *1.39* | *1.81* |
| 51 | —skimmed dehy | 5-01-175 | 94 | 1.15 | 0.45 | 0.84 | 2.16 | 3.23 | 2.48 | 0.90 | 1.58 | 1.58 | 0.43 | 1.13 | 2.30 |
| 52 | Dried Skimmed Milk, Feed Grade (AAFCO) | | *100* | *1.23* | *0.48* | *0.90* | *2.31* | *3.46* | *2.66* | *0.96* | *1.69* | *1.69* | *0.46* | *1.21* | *2.46* |
| 53 | MOLASSES. | | | | | | | | | | | | | | |
| 54 | —sugarcane. *Saccharum officinarum* | 4-04-696 | 75 | — | — | — | — | — | — | — | — | — | — | — | — |
| 55 | Cane Molasses (AAFCO) | | *100* | — | — | — | — | — | — | — | — | — | — | — | — |
| 56 | OATS. *Avena sativa* | | | | | | | | | | | | | | |
| 57 | —grain | 4-03-309 | 89 | 0.57 | 0.15 | 0.09 | 0.53 | 0.09 | 0.34 | 0.18 | 0.60 | 0.40 | 0.12 | 1.07 | 0.70 |
| 58 | | | *100* | *0.64* | *0.17* | *0.10* | *0.60* | *0.10* | *0.38* | *0.20* | *0.67* | *0.45* | *0.14* | *1.20* | *0.79* |
| 59 | PEANUT. *Arachis hypogaea* | | | | | | | | | | | | | | |
| 60 | —kernels, meal solv extd | 5-03-650 | 92 | 5.90 | — | 1.20 | 2.00 | 3.70 | 2.30 | 0.40 | 2.70 | 1.50 | 0.50 | 1.80 | 2.80 |
| 61 | Solvent-Extracted Peanut Meal (AAFCO) | | *100* | *6.45* | — | *1.31* | *2.19* | *4.04* | *2.51* | *0.44* | *2.95* | *1.64* | *0.55* | *1.97* | *3.06* |
| 62 | PHOSPHATE. | | | | | | | | | | | | | | |
| 63 | —defluorinated grnd | 6-01-780 | 100 | — | — | — | — | — | — | — | — | — | — | — | — |
| 64 | Phosphate, Defluorinated (AAFCO) | | *100* | — | — | — | — | — | — | — | — | — | — | — | — |
| 65 | RYE. *Secale cereale* | | | | | | | | | | | | | | |
| 66 | —grain | 4-04-047 | 88 | 0.53 | 0.19 | 0.26 | 0.50 | 0.69 | 0.42 | 0.17 | 0.57 | 0.36 | 0.13 | 0.26 | 0.60 |
| 67 | | | *100* | *0.60* | *0.22* | *0.30* | *0.56* | *0.78* | *0.48* | *0.19* | *0.64* | *0.41* | *0.14* | *0.30* | *0.68* |
| 68 | SORGHUM. *Sorghum vulgare* | | | | | | | | | | | | | | |
| 69 | —grain | 4-04-383 | 89 | 0.36 | 0.18 | 0.27 | 0.53 | 1.42 | 0.27 | 0.09 | 0.45 | 0.27 | 0.09 | 0.36 | 0.53 |
| 70 | | | *100* | *0.40* | *0.20* | *0.30* | *0.60* | *1.60* | *0.30* | *0.10* | *0.50* | *0.30* | *0.10* | *0.40* | *0.60* |
| 71 | SOYBEAN. *Glycine max* | | | | | | | | | | | | | | |
| 72 | —seeds, meal solv extd | 5-04-604 | 89 | 3.25 | 0.67 | 1.14 | 2.44 | 3.49 | 2.92 | 0.60 | 2.26 | 1.78 | 0.65 | 1.24 | 2.36 |
| 73 | Soybean Meal, Solvent Extracted (AAFCO) | | *100* | *3.65* | *0.75* | *1.27* | *2.73* | *3.92* | *3.28* | *0.68* | *2.53* | *2.00* | *0.72* | *1.40* | *2.65* |
| 74 | —seeds wo hulls, meal solv extd | 5-04-612 | 90 | 3.76 | 0.77 | 1.26 | 2.57 | 3.82 | 3.22 | 0.72 | 2.57 | 1.92 | 0.69 | 2.01 | 2.72 |
| 75 | Soybean Meal, Dehulled, Solvent | | *100* | *4.16* | *0.85* | *1.40* | *2.85* | *4.23* | *3.57* | *0.80* | *2.85* | *2.12* | *0.76* | *2.23* | *3.02* |
| 76 | Extracted (AAFCO) | | | | | | | | | | | | | | |
| 77 | SUNFLOWER. *Helianthus* spp. | | | | | | | | | | | | | | |
| 78 | —seeds wo hulls, meal solv extd | 5-04-739 | 93 | 3.37 | 0.72 | 1.00 | 1.94 | 2.60 | 1.67 | 1.03 | 2.06 | 1.50 | 0.56 | — | 2.25 |
| 79 | Sunflower Meal, Dehulled, Solvent | | *100* | *3.62* | *0.78* | *1.08* | *2.09* | *2.80* | *1.79* | *1.10* | *2.22* | *1.61* | *0.60* | — | *2.43* |
| 80 | Extracted (AAFCO) | | | | | | | | | | | | | | |
| 81 | TIMOTHY. *Phleum pratense* | | | | | | | | | | | | | | |
| 82 | —hay, s-c, midbloom | 1-04-883 | 88 | — | — | — | — | — | — | — | — | — | — | — | — |
| 83 | | | *100* | — | — | — | — | — | — | — | — | — | — | — | — |
| 84 | WHEAT. *Triticum* spp. | | | | | | | | | | | | | | |
| 85 | —bran | 4-05-190 | 89 | 0.96 | 0.25 | 0.35 | 0.58 | 0.90 | 0.58 | 0.17 | 0.50 | 0.43 | 0.33 | 0.40 | 0.73 |
| 86 | Bran (CFA) | | *100* | *1.08* | *0.28* | *0.39* | *0.65* | *1.02* | *0.65* | *0.19* | *0.56* | *0.48* | *0.37* | *0.45* | *0.83* |
| 87 | Wheat Bran (AAFCO) | | | | | | | | | | | | | | |
| 88 | —grain, hard red spring | 4-05-258 | 89 | 0.59 | 0.24 | 0.24 | 0.59 | 0.90 | 0.36 | 0.19 | 0.68 | 0.37 | 0.14 | 0.57 | 0.59 |
| 89 | | | *100* | *0.67* | *0.28* | *0.27* | *0.67* | *1.01* | *0.41* | *0.21* | *0.76* | *0.41* | *0.16* | *0.64* | *0.66* |
| 90 | —grain, hard red winter | 4-05-268 | 89 | 0.57 | 0.25 | 0.22 | 0.57 | 0.87 | 0.38 | 0.23 | 0.65 | 0.39 | 0.18 | 0.50 | 0.56 |
| 91 | | | *100* | *0.65* | *0.29* | *0.25* | *0.64* | *0.90* | *0.43* | *0.25* | *0.73* | *0.44* | *0.20* | *0.57* | *0.63* |
| 92 | —grain, soft white winter | 4-05-337 | 88 | 0.40 | 0.27 | 0.20 | 0.42 | 0.59 | 0.32 | 0.17 | 0.45 | 0.32 | 0.12 | 0.39 | 0.44 |
| 93 | | | *100* | *0.45* | *0.30* | *0.23* | *0.47* | *0.67* | *0.36* | *0.19* | *0.51* | *0.36* | *0.14* | *0.44* | *0.50* |

ª The first digit is the feed class: (1) dry forages and roughages; (2) pasture, range plants, and forages fed green; (3) silages; (4) energy feeds; (5) protein supplements; (6) minerals; (7) vitamins; (8) additives.

From: Nutrient Requirements of Rabbits, Second revised edition, 1977, The Research Council, National Academy of Sciences Press.

Table 3-6
Rabbit Feed Substitution Table

| Feedstuffs | Relative Feeding Value (lb for lb) in Comparison with the Designated (underlined) Base Feed Which = 100 | Maximum Percentage of Base Feed (or comparable feed or feeds) Which it Can Replace for Best Results | Remarks |
|---|---|---|---|
| GRAINS, BY-PRODUCT FEEDS, ROOTS AND TUBERS:[1] (Low and Medium Protein Feeds) | | | |
| *Oats* | *100* | *100* | Most preferred concentrate by rabbits; should be rolled. |
| Barley | 110 | 100 | Should be rolled. |
| Beets: | | | Do not feed to rabbits in production or young less than 3 months old. Do not feed to other rabbits in excess of 1½% of body weight. |
| Garden | 10 | 10 | |
| Mangel | 10 | 10 | |
| Sugar | 10 | 25 | |
| Buckwheat | 95 | 100 | |
| Cabbage, aerial | 10 | 10 | Same precautions as with beets; can cause goiter if fed in high amounts. |
| Carrots, roots | 10 | 10 | Same precautions as with beets. |
| Chicory | 65 | 10 | Same precautions as with beets. |
| Corn | 125 | 100 | Should be cracked in order to maximize digestibility. |
| Kale | 15 | 10 | In excessive amounts, kale produces a strong odor in the urine. |
| Kohlrabi | 15 | 10 | |
| Potato, roots | 25 | 10 | Cut out green buds before use. |
| Potato, peelings | 25 | 10 | |
| Rutabagas, roots | 10 | 10 | Same precautions as with beets. |
| Rye | 100 | 35 | May have palatability problems. |
| Sorghum | 125 | 100 | |
| Sunflower seeds | 115 | 100 | Excellent feed, but it is commonly used for other purposes than rabbit feed. |
| Sweet potato, roots | 25 | 10 | Same precautions as with beets. |
| Turnips, roots | 10 | 10 | Same precautions as with beets. |
| Wheat, grain | 120 | 100 | |
| Wheat, bran | 120 | 100 | Has laxative properties; make sure the ration has adequate fiber. |
| Wheat, middlings | 130 | 100 | Has laxative properties; make sure the ration has adequate fiber. |
| Wheat, mill run | 115 | 100 | Has laxative properties; make sure the ration has adequate fiber. |
| Wheat, red dog | 125 | 100 | Has laxative properties; make sure the ration has adequate fiber. |
| PROTEIN SUPPLEMENTS: | | | |
| *Soybean meal* | *100* | *100* | |
| Brewers' dried grain | 65 | 50 | |
| Cottonseed meal | 100 | 100 | Should be degossypolized. Can replace soybean meal up to 7% of the ration. |
| Linseed meal | 80 | 100 | Has laxative properties. |
| Peanut meal | 100 | 100 | Most preferred supplement by rabbits. |
| Sesame seed meal | 100 | 100 | |
| Soybean seeds | 85 | 100 | Unpalatable if fed raw. |
| Sunflower meal | 70 | | |

[1] Roots and tubers are of lower value than grain and by-product feeds due to their higher moisture content.

*(Continued)*

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Table 3-6
Rabbit Feed Substitution Table
Page 2

| Feedstuffs | Relative Feeding Value (lb for lb) in Comparison with the Designated (underlined) Base Feed Which = 100 | Maximum Percentage of Base Feed (or comparable feed or feeds) Which it Can Replace for Best Results | Remarks |
|---|---|---|---|
| DRY FORAGES: | | | |
| *Alfalfa, hay* | *100* | *100* | Eliminates or lessens protein supplement requirement. |
| Bluegrass hay | 50 | 33⅓ | |
| Clover hay | 60 | 100 | If the rest of the ration is adequate in protein, clover is equal to alfalfa in feed value; otherwise, it will be lower. |
| Cowpea hay | 70 | 100 | |
| Johnsongrass hay | 30 | 25 | |
| Kudzu hay | 65 | 100 | Thrives in the southeastern states. |
| Lespedeza hay | 60 | 100 | Feed value varies with the stage of maturity at which it is cut. |
| Oat hay | 40 | 33⅓ | Lower feed value if not cut at early dough state. |
| Peanut hay | 50 | 100 | |
| Prairie grass hay | 15 | 10 | |
| Sudangrass hay | 55 | 33⅓ | |
| Timothy hay | 35 | 33⅓ | |
| Vetch hay | 70 | 100 | |
| GRASSES: | | | |
| *Alfalfa:* | *100* | *100* | |
| Bermudagrass | 90 | 33⅓ | |
| Canadian bluegrass | 100 | 50 | |
| Carpetgrass | 90 | 33⅓ | |
| Clover, red | 90 | 100 | |
| Colonial bentgrass | 115 | 100 | |
| Crotolaria | 65 | 33⅓ | |
| Dallisgrass | 75 | 33⅓ | |
| Dandelion | 70 | 33⅓ | |
| Foxtail millet | 80 | 33⅓ | |
| Kentucky bluegrass | 95 | 50 | |
| Kudzu | 95 | 100 | Abundant in southeastern states. |
| Lespedeza | 95 | 100 | |
| Meadow fescue | 90 | 50 | |
| Napiergrass | 90 | 50 | Low crude protein but high TDN values. |
| Oatgrass | 70 | 33⅓ | Low crude protein content. |
| Orchardgrass | 90 | 50 | |
| Pigeon pea | 100 | 100 | |
| Red fescue | 100 | 50 | |
| Redtop grass | 90 | 50 | |
| Rhodesgrass | 65 | 33⅓ | Low crude protein. |
| Sudangrass | 50 | 33⅓ | |

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# RABBIT MANAGEMENT

## Care of Rabbits

### Gestating Does

Some of the information concerning special care for gestating does is covered in other readings on rabbits. For information on feeding refer to the nutrition section. Information on diseases and parasites can be found in its own section. Housing needs remain the same with the exception of the kindling box. The kindling box should be placed in the doe's cage on the 28th day of her 31 day gestation period. Special handling requirements, such as palpation, are covered under Management for Rabbits.

Volunteers should remember that rabbits are delicate animals that can be highly stressed by mishandling, abuse, and climate. This is especially true for gestating does because of the production demands placed on them. It is important to keep the doe disease and parasite free during gestation. Treatment for parasites and with any antibiotics should be avoided if possible during this time. Regular and gentle care is especially important. Excessive handling of the doe, or changing her cage (thus affecting her territorial nature), should be avoided.

### Kindling and Lactating Does

For information on kindling, read pages 25, 26 and 27 of the Vita book. Water and feed requirements for this period are covered in the nutrition section. It is especially important to provide good feeds, clean water, and good care during this time because kindling and lactation place the highest production demands on does and any stresses during this time will significantly lower production. It is important not to handle either the doe or the litter for two or three days before or after kindling. It is also important to keep the kindling box clear in order to prevent coccidiosis. If you must handle the young during their first week of life, put vanilla on the nose of the doe to mask your scent so that she will not cannibalize the young. If you find a doe to be more than normally nervous, you can cover the cage with a tarp or blanket on the 31st day of gestation so that she can kindle in a quiet, dark place. This may reduce her nervousness and help to produce a better litter. Remember not to be overzealous or motherly in your care of does. If the feed and management conditions are good, the doe will take care of herself and the litter without a lot of unneeded assistance. The curiosity of people wishing to view the litter can be stressful for the doe. The nest box should be removed when the litter is 2 to 3 weeks old.

### Care of Young Litters

After the doe has kindled, gently and quietly examine the litter to see how many were born, remove any dead or deformed young, and check to see if they have nursed (indicated by their full bellies). If this is done quietly while the doe is out of the nest box, she will not be disturbed and will not cannibalize or disown the young. Also, make sure that the nest of fur (and possibly straw) is adequate to keep the young warm, but not too hot. You may need to adjust the amount of bedding to the outside temperature to prevent overheating or chilling. Allow for good drainage from the nestbox. If there are too many in the litter, transfer some to other litters, or if there are too few, bring in young from other litters. These transfers should be made a day or two following kindling and between litters that do not vary more than one to three days in age. Some does may accept young of varying ages. If more fur is needed to keep the young warm you can pluck fur easily from the doe's belly. If there is excess fur, save it for a future time. Keep your records caught up-to-date when the doe kindles.

## REPRODUCTION

### Number of bucks

One buck should be kept for every 10 to 15 does. A mature, vigorous buck can be used 3 or 4 times a week.

### Age to Breed

Sexually, the smaller breeds mature much earlier than the heavier breeds, the small Polish usually being ready to start production at 4 months of age, the medium weight New Zealand and Californian at five to six months, and the heavy Flemish at 6-7 months. Within breeds, these dates may vary depending on the nutrition of each individual rabbit.

### Mating

Information on mating is contained on pages 23-25 of Raising Rabbits by Harlan D. Attfield (see Appendix A). It should be noted that rabbits do not have timed estruses as do other animals. The act of mating will cause the doe to ovulate. Also, some does may have extended periods when they are not fertile due to reactions to the climate. Extreme heat (over 30°C) can lower conception rates. If, when you place the doe with the buck to mate, nothing occurs, try the doe with another buck. If you still get no response, try another day. Mating should be done during the cooler times of the day. Avoid using hand-breeding of does if possible because conception rate is lower than with naturally mated does. The illustrations in the Vita book can help in understanding this process.

### Factors that prevent conception

#### 1. Sterility

In its natural environment the wild rabbit breeds during the spring and early summer and is barren during the fall and winter. During this barren period, the ovaries become somewhat shriveled and inactive, and fail to produce normal egg cells; bucks may fail to produce sperm, or the sperm may lack motility or be abnormal in development. In developing the domestic rabbit, humans have shortened the barren period somewhat. Its duration and intensity vary considerably. Some does and bucks are affected while others are not. This condition is more common in areas with excessively high temperatures. Poor feed may also cause sterility as well.

#### 2. Physical condition

Rabbits that are underfed or overfed and become either too thin or too fat will be poor breeding stock.

#### 3. Pseudopregnancy

Pseudopregnancy can result from a sterile mating or from stimulation caused by one doe riding another, or by a doe riding the young in her own litter. This condition will last for about 17 days. During this time the doe may not conceive. This condition can be detected by palpating does to determine conception 14 days after mating.

4. Sore Hocks, Injuries, or Disease

All three of these are stressful to bucks and does therefore affecting their vitality and their ability to reproduce. Rabbits who have any of these 3 problems should not be used for breeding.

5. Retained fetus

In rather rare instances, a doe may fail to deliver the entire litter, and the tissues of the retained fetus will be absorbed and the bones will remain in the uterus. This can be detected by someone experienced with palpation. Any doe with such a condition should be culled from the herd.

## Weaning

This is discussed on pages 28 and 29 of Raising Rabbits by Harlan D. Attfield (see Bibliography and resource material in Appendix A). In high management environments, with the best of feed and care, rabbits can be weaned at 4 weeks of age. However, for volunteers working in low to moderate production environments I do not recommend weaning before 8 weeks of age. The extra 4 weeks of nursing will improve litter survivability. Rabbits are territorial animals; to lessen the stress of weaning always remove the doe from the cage, rather than removing the fryers. The doe is more tolerant of the stress of being moved than the fryers.

# HANDLING OF RABBITS

On page 46 of Raising Rabbits (see Bibliography and resource material in Appendix A) there is a drawing that illustrates the different anatomical parts (dewlap, flank, loin, etc.) of a rabbit. Familiarity with these terms is valuable in avoiding confusion later when talking about the anatomy of rabbits.

Three different ways to hold a rabbit are illustrated on pages 16 and 17 of VITA. The position you use to hold a rabbit will depend on the size of the rabbit.

The method used for determining the sex of young rabbits is explained and illustrated on page 29 of Raising Rabbits (see Bibliography, Appendix A). This technique is one that requires practice to be accurate. You will not be right every time when you are learning how to sex rabbits.

Palpation is the process of feeling for the young rabbits while still in the uterus of the doe in order to determine pregnancy. Palpation, like sexing of young rabbits, is a good and reliable "test" but it does require practice in order for the results to be accurate. The written explanation of this technique on page 25 of Raising Rabbits (see Bibliography and resource material in Appendix A) should give you an idea how to practice this technique. It is important that you be gentle with the doe and careful not to press too hard or you may injure the doe or her fetuses.

## Slaughter, Disease Diagnosis, and Post Mortem Procedures

For information on the slaughtering of rabbits, read pages 45 to 49 of your VITA text. Information on the tanning of hides is contained on pages 50 and 51 of Raising Rabbits by VITA.

Some diseases can be diagnosed by observation of clinical signs while the rabbit is living. Other diseases cannot be diagnosed without a post-mortem examination and, in some cases, special techniques. As a rabbit raiser, you should become familiar with the normal physiological characteristics of a rabbit and the normal appearance of the internal organs. You can accomplish this by learning a few facts such as the normal temperature, 102°-105°F; the normal pulse rate, 140-150; the normal respiration rate, 50-60; and the normal general appearance of a healthy rabbit stool (manure). You can only learn the normal appearance of the internal organs by repeated examination of these organs when normal rabbits are slaughtered. Then, when a rabbit dies for some unknown reason, you will be prepared to do your own post-mortem examination. With a little practice, you may become proficient in diagnosing the more common diseases and with this information be able to take immediate measures for preventing an outbreak of a certain disease.

In making the post-mortem examination, remove the pelt to facilitate examination of the carcass. After removing the pelt, place the animal on its back and make a midline incision through the body wall. This will reveal the internal organs. Examine the lungs and the heart in the thoracic cavity. If the lungs are normal, they will be a pale pink color. If the lungs are purple or have purple and pink splothes, or yellow spots, they are probably diseased. Hemorrhages and red spots in the lungs may be seen if the animal has struggled while dying. Next, examine the organs in the abdominal cavity (the thoracic and abdominal cavities are separated by the diaphragm). The large organ closest to the diaphragm is the liver. It should be purplish red, very smooth, and shiny. A change in color or the presence of white spots signals disease.

Next examine the digestive tract, starting with the stomach. The stomach lays under the liver. It should be filled with a very wet mix of rabbit feed and water. Occasionally you will see fecal pellets (manure) in the stomach. This is normal, as rabbits practice coprophagy (eating their own fecal pellets). The long tubular structure coming from the bottom of the stomach is the small intestine. Its contents are scant and almost slimy. The small intestine empties into a large organ called the cecum. The contents of this part of the digestive tract should be semi-solid (somewhat like putty). If you find the cecum and/or small intestine to be two or three times normal size and the contents very watery, you should suspect an enteric problem. You may also see a reddening of the walls of these organs due to hemorrhage. The cecum empties into the colon, or large intestine. This organ is smaller than the cecum and normally should contain the round fecal pellets. Diseases in this organ would be signaled by vaseline-like contents, or no fecal pellets.

After examining the digestive tract, look at the kidneys, located underneath the digestive tract and normally encased in fat. They are two walnut size organs lying on either side of the backbone. They should be brownish to purple, with a smooth surface. A rough surface, change in color, or white spots indicate disease. The bladder and reproductive organs are the last structures to be examined in an internal post-mortem examination. The bladder is located at the posterior end of the abdominal cavity. It looks like a small balloon when filled with urine. The bladder wall is normally quite thin, and the normal urine is cloudy. Because the rabbit excretes large amounts of calcium, the urine will often feel a little granular due to calcium crystals. The ovaries and uterus in females and the penis and testicles in males should be examined. Each ovary is located at the end of the uterine horn near the kidneys. They are very small, about bean size. They often will have little blister-like structures on them which contain the developing eggs. The uterus should be about the same color as the body wall. An enlarged uterus containing a whitish fluid indicates disease.

If you are continuing to have a disease problem that you cannot diagnose, take both the sick and dead rabbits to the government operated diagnostic laboratory (if one is available to you).

## Ear Tattooing

The prolific nature of rabbits makes precise recordkeeping even more of a necessity than with other animals. In order to have a means of identification on which to base the recordkeeping system, it is necessary to tattoo a permanent identification mark into the ear of the rabbit. Tattooing numbers or letters into the ears of rabbits does not disfigure the ear, is permanent, and is not difficult to do. However, the actual tattooing requires practice in order to be able to make a permanent mark. The system of tattooing described below is one that does not require the expensive (and often unavailable) tattooing pliers or tongs. Instead, a simple sewing needle can be used. Either the right or left ear should be chosen to receive the rabbit identification number and the opposite ear should be used to contain the litter number. For example, if you decide to place the rabbit's individual identification number in the right ear and the number of the litter he/she was born within the left ear, then you should continue to always use this system in order to not confuse the rabbit ID number with the litter number. Listed below are the materials needed for this technique and a step-by-step explanation of the process.

### Materials

One bottle of a indelible India ink
Alcohol
Cotton
One sharp sewing needle
Tape

### Process

1. Wrap the end of the needle with tape to give yourself a better grip on the needle.

2. Have one person restrain the rabbit with all feet flat on a table, or other flat surface, so that it cannot thrash about during the tattooing and injure itself. To do so one can cup the hands on the back of the rabbit and press downward gently to restrain it.

3. Pick a spot in the center of the ear (avoiding any veins or arteries) and lightly swab the inside of the ear with an alcohol soaked piece of cotton.

4. Lightly (with a pencil) draw into the rabbit's ear the numbers you wish to tattoo in the position you choose.

5. Then firmly grasp the needle, dip it in the ink, and lightly puncture a series of small dots into the ear in the shape of the number or letter chosen. While piercing the ear with the needle your opposite hand should be holding the ear in such a manner to provide access into the area you are tattooing while one of your fingers is on the backside of the ear providing a supporting surface against which to press the ear and needle.

6. You should pierce the outer membrane of the ear and the needle should pass approximately half way through the skin of the ear in order to create a permanent mark. If you pass all the way through the skin of the ear, the rabbit may cry out and struggle to get free. You will also poke yourself in the finger of the opposite hand. If this occurs, calm the rabbit and yourself down and try again.

7. When you have completed the tattoo rub a small portion of ink into the new letter or number with cotton in order to improve the permanence of the mark.

8. After you have completed all the tattooing, you should return within 48 hours to see which of the tattoos "took" and which are too light to be legible and need to be redone. As you gain experience and practice, fewer of the tattoos will fade and need to be redone.

There is no reason to tattoo a new litter as long as they remain with the doe. However, when the fryers are weaned and separated from the doe then they need to be tattooed for identification of their individual number and for the number of the litter they were born with in order to keep track of the various litters. Weaning is also a good time to consider selecting rabbits as future breeding stock, as well as sexing. Tattooing prior to weaning is not a good idea because the small size of the rabbit makes it physically difficult and litter losses prior to weaning make it unnecessary.

## Treatment for Disease and Parasites (Internal and External)

For precise information on the treatment of specific diseases and parasites refer to the disease section of the guidelines for rabbits.

# Rabbit Recordkeeping and Field Notebooks

The two pages of sample records included for rabbits in the guidelines are included to show another system of recordkeeping other than the records contained on pages 31 to 37 of Raising Rabbits by VITA. Neither system is necessarily any better than the other. It should be remembered that record keeping is a management tool and, as such, should be appropriate to the level of management of a given project. Recordkeeping is a critical part of managing a rabbit project due to the prolific nature of rabbits. Depending on the size of your colony you may find that you need to update your records a couple of times a week or even daily. The records included in the VITA text and in the guidelines are breeding and production records. You may find it necessary to keep separate records on the financial end of the project, as well as feed consumption records.

It is advisable to have only 1 or 2 people in charge of keeping the records up to date. Too many people involved in the care of the rabbits as well as the recordkeeping can create a poor management environment in which no one person feels responsible and can be stressful for the rabbits as well.

Financial records should be kept in order to determine costs of production. If one knows the cost of production (feeds, wire, medications, etc.), your f/g ratio, the market price for rabbit meat, and any incidental expenses then you can determine your profit or loss on the operation. Basic bookkeeping skills are important and is a skill you may wish to transfer to your counterpart before the end of your two years of service.

Feed production records are simply keeping track of the amount and cost of the feed consumed by the records.

Your field notebooks should serve to complement the records that you are keeping on record production. General observations on the individual health or the collective herd health could be entered into your field notebook, as could dates of any medical treatments, notes on new breeding stock, marketing information, and anything to do with the producion of your feed ration.

In addition to these pages in the guidelines, read pages 31 to 37 of Raising Rabbits by VITA on recordkeeping.

## Illustration 3-1
## Buck Breeding Record

### *Buck Breeding Record*

Cage Location ____________

Ear # ____________ Sire ____________

Born ____________ Dam ____________

Breed ________________________

| Sire Performance | | | | | | Mortality | Litter Growth |
|---|---|---|---|---|---|---|---|
| | | | Fertility | | | | |
| Doe | Cage Location | Date of Service | Conception Score* | Number Born | Number Born Alive | Number of Kits That Died from 1 to 56 Days | Total Litter Weight at 56 Days of Age |
| | | | | | | | |
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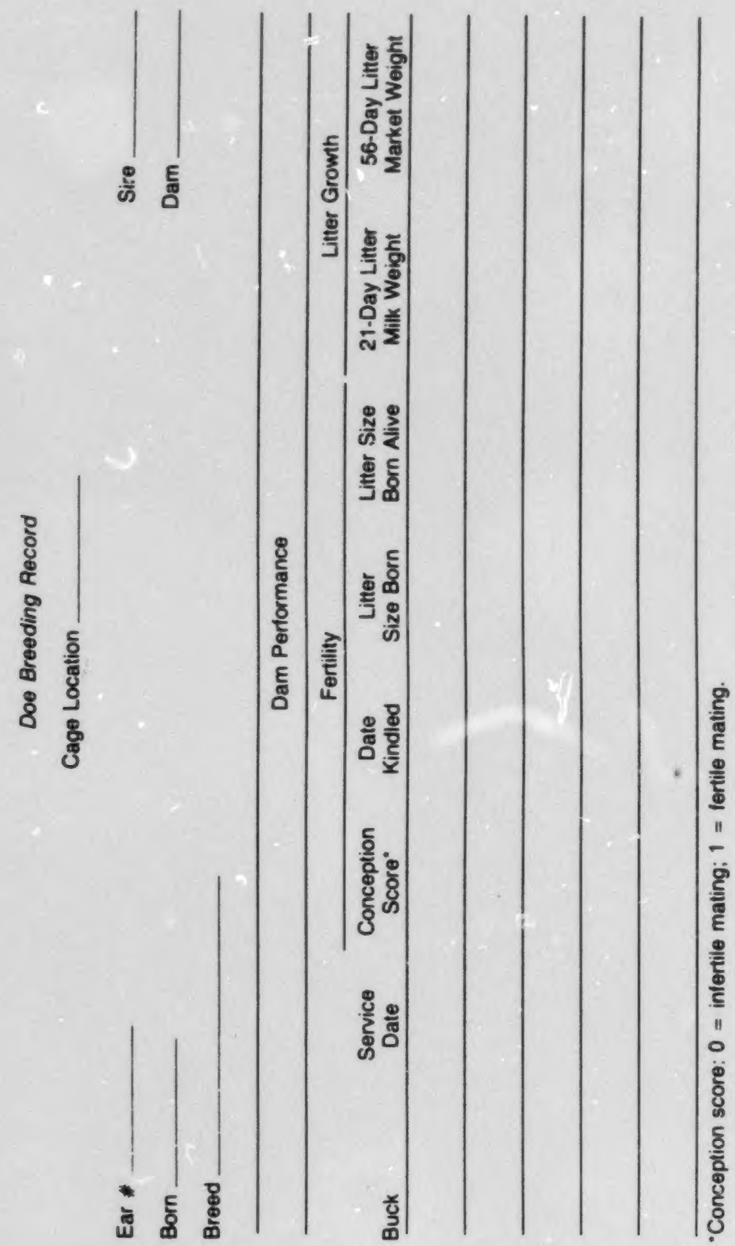
*Conception score: 0 = infertile mating; 1 = fertile mating.

**An example of a buck performance record sheet.**

From: Rabbit Production, by Cheeke, Patton and Templeton, Interstate Printers and Publishers, Inc., Danville, Illinois, 1982 with permission.

Illustration 3-1
Doe Breeding Record
Page 2



*Doe Breeding Record*

Cage Location ____________

Ear # ____________
Born ____________
Breed ____________

Sire ____________
Dam ____________

| Dam Performance | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Fertility | | | | Litter Growth | |
| Buck | Service Date | Conception Score* | Date Kindled | Litter Size Born | Litter Size Born Alive | 21-Day Litter Milk Weight | 56-Day Litter Market Weight |
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*Conception score: 0 = infertile mating; 1 = fertile mating.

An example of a doe performance record sheet.

From: Rabbit Production, by Cheeke, Patton and Templeton, Interstate Printers and Publishers, Inc., Danville, Illinois, 1982 with permission.

Illustration 3-2

## RABBIT CAGE RECORD CARD

NAME OR EAR NO. ____________ BORN ____________ CAGE NO. ____________

SIRE ____________ DAM ____________

| SERVED BY | DATE | TESTED | KINDLED | NUMBER OF YOUNG | | | | | JRS. SAVED | | WEIGHT | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | BORN | LEFT | ADDED | RAISED | DIED | BUCKS | DOES | | |
| | | | | | | | | | | | | |
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## BUCK RECORD CARD

EAR NO. ____________ CAGE NO. ____________

BORN ____________ SIRE ____________ DAM ____________ WEIGHT 2 MOS. ____________

| DOE SERVED | DATE | LITTER SIZE | WEIGHT | JRS. SAVED | |
|---|---|---|---|---|---|
| | | | | Bucks | Does |
| | | | | | |
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| DOE SERVED | DATE | LITTER SIZE | WEIGHT | JRS. SAVED | |
|---|---|---|---|---|---|
| | | | | Bucks | Does |
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From: Rabbit Production, by Cheeke, Patton and Templeton, Interstate Printers and Publishers, Inc., Danville, Illinois, 1982 with permission.

## Credibility Techniques - Rabbits

Listed below are several credibility techniques that a volunteer can use for working with rabbits. For information on the value of credibility techniques, read the credibility technique section of management for swine.

1. Ear tattooing
2. Proper postmortem technique
3. Kindling boxes for the kindling does
4. Palpation
5. Sexing of fryers
6. Construction of low-cost cages
7. Prevention of diseases and parasites through sanitation
8. Recordkeeping
9. Using a manger to keep feed off the floor of the cage
10. Tanning of hides
11. Placing twigs in the cages for the rabbits to gnaw on
12. Use of a coccidostat
13. Providing shade from the sun and preventing drafts
14. Demonstrating proper handling of rabbits (to prevent injuries)

## Rabbit Diseases

In the Introduction to Disease section of these guidelines and in the sections on swine and poultry disease, we have emphasized that prevention of disease is a basic premise of good management. It is especially important for working with rabbits in the tropics where the combination of a hot climate coupled with limited access to medications makes treatment of diseases that infect the herd either impractical or impossible. Good sanitation is the key to preventing diseases in rabbits. This can be accomplished through the use of self-cleaning (wire) floored cages and through the regular use of disinfectants to clean the cages. If the rabbits are being raised on any type of solid floor, it is critical that the floor be cleaned and disinfected regularly. Contact between the feces and/or urine and the rabbit is sure to spread disease. Disinfectants such as lye, soap and water, chlorine, or sunlight can all be used to disinfect cages.

Disease diagnosis is difficult even under the best of situations for farmers and volunteers in the field without access to a veterinarian and lab testing facilities. However, proper post mortem procedures can provide the volunteer with clues that will limit the range of possible disease(s) that are present in the herd. If there is a disease outbreak in the herd it may be, depending on the local conditions and access to medications, more appropriate to isolate and cull diseased rabbits than to attempt to cure infected animals. However, this is a management decision that each farmer and volunteer must make in each individual case. The information that follows is designed to assist the volunteer in preventing, diagnosing, and treating diseases as they affect the rabbits.

### Bacterial Diseases

### 1. Pasteurellosis

Pasteurellosis is the designation for all diseases associated with Pasteurell multocida. The disease manifestations are varied and include snuffles, pneumonia, pyometra, orchitis, otitis media, conjunctivitis, subcutaneous abcesses, and septicemia.

### A. Snuffles

The mucous membranes of the nasal sinuses become infected by bacteria from air that is breathed in or by direct contact with infected animals or contaminated objects. The clinical disease is characterized by a mucus or pus nasal discharge. The extent to which the infection spreads into the lower respiratory passages depends on the virulence of the bacteria and the susceptibility of the animal. A rabbit on a poor diet or highly stressed by a lack of water or high temperature is more susceptible. If the disease is confined to the upper passages, the first signs are sneezing followed by a nasal discharge. The forepaws of the rabbit may be caked with exudate because of attempts to wipe the exudate away from the nose. Pasteurella bacteria are sometimes found in the nasal sinuses of healthy-appearing rabbits. Stress resulting from extremes of temperature, high humidity, pregnancy, and lactation is a primary factor in the development of the snuffles.

## B. Pneumonia

Upper respiratory disease (snuffles) may spread to the lungs and cause pneumonia. In the tropics, this disease can commonly occur at the beginning of the wet season. It is the single greatest cause of death in mature rabbits. Signs of pneumonia are depression, labored breathing, bluish eye color in albinos, and a nasal discharge. The body temperature is usually above normal.

Gross lesions of the lungs appear as red consolidated areas, sunken purple areas, and abscesses. The consolidated lesions are most often found in the anterior lobes of the lungs. A exudate is often found in the air passages. Absceses with thin fibrous capsules appear close to the surface of the lungs. Sometimes there are adhesions between the wall of the chest cavity and the lungs. Good ventilation without drafts, low humidity, and treatment with antibiotics are recommended. Pasteurella organisms are sensitive to oxytetracyclines, streptomycin, sulfaquinoxaline, and furazolidone.

## C. Pyometra

Pyometra means pus in the uterus. The walls of the uterus are usually dilated, and the organ is filled with pus. Affected does will not reproduce and, therefore, are best culled and slaughtered. Pyometra results from the introduction of Pasteurella bacteria into the uterus during mating and may be traced to a single buck with a chronic infection of the testicles. Treatment of the disease is not practical and the disease is quite difficult to diagnose.

## D. Orchitis

Orchitis is an infection of the testicles of a buck. The testicle becomes enlarged and contains an abscess. Pus can be seen when the testicle is cut open. Sometimes infection is limited to the membranes covering the penis, and this is called balanoposthitis. Balanoposthitis appears as a reddening and swelling of the membrane covering the penis, and a white exudate (pus) is present on these membranes. As described above, the infection is transmitted to does by infected bucks during breeding. Treatment is seldom attempted; however, it may be treated by applying antibotic ointment containing penicillin to the penis.

## E. Otitis Media

Middle ear infection of one or both ears causes filling of the tympanic cavity with a purulent pus. If the process spreads to the inner ear, the equilibrium of the rabbit is disturbed and head tilt or wryneck results. Although the Pasteurella organism is sensitive to certain antibiotics, treatment is generally not effective because of the isolated location of the infection. Culling and slaughter are recommended.

## F. Conjunctivitis

Conjunctivitis, or weepy eye, is infection of the membranes that cover the surface of the eye and the inner part of the eyelids. The eyelids are swollen, and white pus may cover the eye and surrounding fur. Infection of the eye usually occurs as a result of extension of the infection from the nasal cavity (snuffles). Antibiotic ophthalmic ointment containing penicillin is used to treat this form of the disease.

### G. Subcutaneous Abscesses

Pasteurella may cause abscesses in many organs, but abscesses are especially evident when they occur in the subcutaneous tissue. These appear as soft swellings under the skin. Treatment consists of opening and draining of the abscess and applying antibiotic ointment.

### H. Septicemia

This disease is usually an overwhelming blood stream infection of short duration without clinical signs. Tissue changes are limited to a few hemorrhagic areas of the heart and pericardium, swelling of the spleen, and slight congestion of the upper digestive tract. The lack of clinical signs and short duration do not allow time for suitable treatment.

## 2. Listeriosis

Poor husbandry and stress may be important factors in initiating this disease. It is a sporadic septicemic disease characterized by sudden deaths, abortions, or both. Generally, the rabbit is depressed, weak, has a nasal discharge, and may have convulsions. Diagnosis prior to death is quite difficult and therefore treatment is rare. Postmortem examination may reveal lesions on the liver that are multiple pin-point gray-white focci. In the case of metritis, the uterine wall is thickened, the mucous membrane may be covered with a grayish exudate, and the fetuses are decomposed or mummified. If the infected fetuses are retained in the uterus a severe infection may occur. Pregnant does and those does that have recently kindled are the most susceptible. Quarantine and treatment with tetracyclines are recommended.

## 3. Necrobacillosis

Fusobacterium necrophorum in farm animals is considered a secondary invader rather than a primary cause of disease. Lesions first appear on the lower lip, which becomes swollen, purplish, and painful to the touch. Later, small abscesses are seen that contain a thick, purulent material. These abscesses are enclosed in a tough, fibrous capsule, with little tendency to rupture and drain. When the liver and lungs become involved, the rabbit becomes emaciated and dies after several weeks. Infection usually is associated with fecal contamination of skin wounds under unsanitary conditions. Infected rabbits should be quarantined and the lesions can be treated by opening and draining the abscesses and applying iodine or a tropical sulfonamide.

## 4. Salmonellosis

Naturally occuring Salmonella typhimurium infections are uncommon in domestic rabbits. Salmonella organisms are easily spread by feacl contamination, and a single infected rabbit can quickly infect a whole colony. Rabbits can also become infected by human caretakers as the salmonella bacteria occur in humans as well. Infection usually takes place by the oral route, and signs appear after 3-6 days. The first signs are listlessness, ruffled haircoat, loss of appetite, and diarrhea. Later, the respiration rate increases, and body temperature may rise. In the acute form, the disease progresses rapidly to death, whereas in the chronic form there may be no signs of illness other than a transient diarrhea.

The most prominent lesions found during postmortem examination are in the liver, spleen, mesenteric lymph nodes, lungs, and intestine. Hemorrhagic and ulcerative changes are present in the intestine. The liver and spleen are usually enlarged and contain pinpoint, pale areas of necrosis. The lymph nodes may be soft, hemorrhagic, and enlarged. Surviving rabbits become carriers and may shed bacteria in their feces intermittently for a long time. Streptomycin and nitrofurazone have been used effectively against salmonella. Animals treated with chlortetracycline respond to the medication, but may continue to excrete organisms in their feces long after treatment. Pigeons, sparrows, and wild rodents have been shown to be reservoirs of salmonella. Feed and bedding should be stored so as to protect them from these possible carriers.

### 5. Staphylococcosis or Mastitis (Blue breasts)

Staphylococcus aureus causes septicemic infections as well as abscesses in numerous organs including the subcutaneous tissue, lungs, kidneys, and heart. This organism is especially known for causing infection in the breasts of nursing does (mastitis). The breasts become swollen, hot, and may become bluish accounting for the name blue-breast that is sometimes used.

Cutaneous lesions in young animals appear as small abscesses and later develop into firm nodules. These abscesses are usually found on the lower abdomen, on the inner aspects of the forelegs, and on the lower jaw. Small white nodules may also be found in the lungs and heart. The staphylococcus organism may also cause bronchopneumonia. The lungs appear consolidated with numerous necrotic lesions. The bronchi and trachea may contain a mucropurulent exudate.

Bacteria enter the skin through broken or abraided areas following birth; transmission occurs from mother to young. Staphylococci live in the nasal passages of rabbits, and the close contact associated with kindling and nursing offers opportunities for both direct contact and aerosol transmission.

Mastitis results from invasion of the milk glands by the disease producing bacteria. The glands and teats become red and swollen and may advance to blue-black tissues, which are feverish to the touch. The doe may refuse to nurse her young and generally loses her appetite. Young from does with mastitis should not be fostered out to other nursing does because the disease will be transmitted to the doe. Mastitis may also result from abrasions to the teats or insufficient removal of milk when too few young are left with the doe or when the young are weaned too soon. Staphylococci may be sensitive to several antibiotics including penicillin, tetracycline, streptomycin, and furadantin; however, some strains of the organism are resistant to one or more of these drugs.

### 6. Spirochetosis or Treponematosis (Vent disease)

This disease is caused by Treponema cuniculi. It is a specific venereal disease of rabbits that is not transmittable to humans. It is characterized by denuded or scab-covered areas about the external genitalia. It occurs in both sexes and is transmitted by coitus. Small vesicles or ulcers are formed, which ultimately become covered with a heavy scab. These lesions usually are confined to the genital region, but in some cases, the lips and eyelids may be involved. Infected rabbits should not be mated. Penicillin in daily doses of 50,000 units appears to be specific therapy. Lesions usually heal within 10-14 days and recovered animals can be bred without danger of transmitting the infection.

### 7. Tularemia

Tularemia, sometimes called rabbit fever or deer fly fever, is an infectious disease of wild animals and man that is caused by Francisella tularensis. Tularemia can be carried by many wild and domestic animals, certain birds, deer flies, and ticks. It is an important malady of wild rabbits, not the domestic rabbit.

Infected wild rabbits appear sluggish in movement and are visibly sick. Yellow or while spots on the liver or spleen are common lesions. Domestic rabbits are susceptible to infection with this organism under laboratory conditions, but the disease has not been reported naturally occurring in commercial rabbitries.

### 8. Tyzzer's Disease

This disease is caused by the bacillus piliformis and affects mainly young rabbits 6 to 7 weeks old. Signs of the acute form seen in rabbits are severe diarrhea, listlessness, lack of appetite, and dehydration, followed by death within 1 to 3 days. Lesions include necrosis in the wall of the cecum and focal necrosis in the liver and heart. The organisms are found in cells near necrotic areas, and the demonstration of typical bacteria within the cell is essential to diagnosis. Animals surviving the acute stage may progress to adulthood but fail to grow at the normal rate. Infection occurs by ingestion and is associated with poor sanitation and stress. No treatment is known to be effective.

## Viral Diseases

### 9. Myxomatosis

This disease affects domestic but not wild rabbits, such as jackrabbits. While only mildly affecting wild cottontails, it is a fatal disease for domestic rabbits. The myxoma virus was first isolated in South America from diseased laboratory rabbits. In wild cottontails, it causes only mild tumors, which regress after several weeks; the disease is fatal only in the very young. However, in susceptible domestic herds, the disease can destroy the entire herd. The disease is spread by mosquitoes but does not affect humans. It is also referred to as "big head disease" because of the edema around the eyes, ears, lips, and nose in the early stages of the infection.

Clinical signs include lusterless eyes with a purulent discharge and fever. Edema of the ears causes them to become heavy and pendulous. As the disease progresses, edema of the pelvic region and nasal discharge occur; death follows in 10-12 days. In the few cases that survive, widespread subcutaneous gelatinous tumors develop all over the body.

Rabbits dying from myxomatosis exhibit no characteristic internal changes by which the infection can be clearly diagnosed. Usually, there is congestion and consolidation of the lungs, and the spleen is enlarged, dark red, and pulpy. The cut surface of each subcutaneous tissue is white, gelatinous, and glistening; when pressed, clear fluid exudes. Clinical signs and tissue examination are required for absolute diagnosis through a lab test.

The virus is spread not only by mosquitoes but also by biting flies, biting insects, and fleas, which act as mechanical vectors. Areas that have large mosquito populations, as well as wild rabbit populations, may be endemic areas for this disease. Antibiotics are not effective against this disease but an attenuated vaccine has been developed.

## 10. Rabbit Pox

It is not known how widespread this disease is in tropical countries but it is rare in the U.S. The disease has not been observed in wild rabbits. It is caused by the vaccinia virus. During an outbreak, mortality of unweaned fryers may reach 75%. This disease spreads very rapidly, but rabbits innoculated with smallpox vaccine (vaccinia virus) are immune.

## 11. Fibroma

The rabbit fibroma virus was isolated from nodules beneath the skin of wild cottontail rabbits. These fibromas (growths) were transmitted to both wild and domestic rabbits. Isolated outbreaks have occurred in domestic rabbits although it is far more common among the wild cottontail rabbit populations in the U.S. It is not known how widespread this disease is in other countries.

In the cottontail rabbit, the fibroma virus causes a benign tumor which regresses within a few weeks. Young domestic rabbits, on the other hand, develop small subcutaneous nodules to diffuse indurations involving muscle and tendon. The external genitalia become red and swollen. Death is frequent in unweaned young. The cut surfaces of the nodules are pale and glistening and may have radiating white streaks. In young animals, the tumors are more widely spread over the body and often coalesce. There may be involvement of the kidneys, liver, intestinal tract, bone marrow, and mesentery.

The role of mosquitoes and other insects as vectors of rabbit fibroma virus has been established. In areas with a large mosquito population there may be losses to this disease.

### 12. Herpes Virus

Very little is known about how this virus affects rabbits. It is known, however, to be a latent infection in some stock lines of domestic rabbits. The pathogen is thought to play some role in respiratory diseases.

### 13. Rabbit Papilloma (Warts)

Rabbit papilloma virus was identified as the causative agent of wart-like growth on the skin if cottontail rabbits. The domestic rabbit and the jackrabbit (in the U.S.) are susceptible to experimental infection. The virus produces no evidence of a generalized illness. The most common sites for warts are the ears and eyelids, and the growths vary in size and conformity. The growths are well keratinized, and the upper surfaces are irregular and often split. The lower portions of the growth are pinkish and fleshy to the touch. As the warts become older, they increase in size, become more cornified, and are hard to the touch. At this stage, they are easily scratched off by the rabbit or knocked off when handled. Warts removed in this way leave a free-bleeding surface, which heals without complications.

The rabbit papilloma virus is probably spread by tree-flying insects as the mosquito. There is no virus multiplication in insect tissue. Transmission of the virus from lesions of cottontail rabbits to domestic rabbits is most likely.

### 14. Oral papilloma

Rabbits that are immune to skin warts are susceptible to oral warts and vice versa. Oral warts may occur in herds of domestic rabbits and can be transmitted to wild rabbits. The small, white, nodular or cauliflower-like warts are multiple. They are caused by a virus different from that of skin warts. They occur in the mouth and on the lower surfaces of the tongue. They will normally regress without specific treatment.

## Fungal Diseases

Fungal diseases in rabbits are an indicator of poor husbandry and unsanitary conditions. Two main groups of fungi, Trichophyton and Microporum, are found on the rabbit and produce disease of the skin and fur under certain conditions. Not only may rabbits serve as reservoirs for human infection, but man may transmit his fungus infection to rabbits. Because they produce a similar disease known as ringworms, the two organisms will be discussed together in this section.

Fungus infections cause patchy areas of hair loss with thickened skin covered with yellow, dry crusts. The hairs may be broken close to the skin surface and become matted. The name "ringworm" is suggested by the circular lesion that often develops from the outward growth of the fungi. Lesions are usually found on the nose, ears, eyelids, and feet. Their size varies, and in severe cases whole areas of the body may be involved. The infection is usually most severe in the nursing young; single small lesions are more likely found in the adult. Diagnosis of fungus infection depends on finding fungi in skin and hair scrapings.

Infection on the young probably occurs in the nestbox. The nestbox material becomes contaminated with fungus from the adult, and minor skin abrasions allow the fungus to become established on the young. During nursing, the young are in direct contact with skin and fur around the teats, and the fungus is easily transferred to the mouth and nose regions of the infants. These same fungal organisms are found on dogs, cats, domestic livestock, and wild rodents around farms.

The important thing to remember here is that if you see fungal diseases on rabbits you know that management and sanitation problems exist, hence the possibility for more serious disease. You may not find it appropriate to treat for the fungal infection. Instead culling and slaughter of infected rabbits may be the solution. If you do decide to treat for ringworm you can use hexetidine (a topical medication) to be applied directly to the affected areas, or in the case of widespread outbreaks Griseofulvin can be used. Griseofulvin is an antifungal drug to be mixed in the feed at the rate of .37 grams per pound of feed, and fed for 14 days. During treatment, a fungicidal dust (sulfur) should be added to the nestbox.

## Hereditary Diseases

### 15. Glaucoma

In rabbits glaucoma appears first as a light-bluish cloudiness on the cornea. One or both eyes may be affected. Progressive opacity follows, and protrusion of the eyeball becomes noticeable. Corneal opacity may lead to blindness. Complications associated with glaucoma are difficulty in breeding affected anumals, poor appetite, and a general loss of good health.

Glaucoma is probably the result of an abnormal drainage mechanism and the inability to maintain normal fluid relationships in the eye. It is a semilethal defect that is transmitted as a recessive trait.

### 16. Malocclusion

Malocclusion or wolf teeth is a common minor probem with rabbits. It is especially a problem with rabbits that are kept on pre-mixed feeds only; rabbits that are given more roughage (including twigs and stems from trees) can constantly gnaw and chew in order to keep their teech ground down to proper length and size. When the lower jaw is shorter or longer than the upper jaw, malocclusion of the incisors results in overgrowth. The cheek teeth (premolars and molars) meet and grind evenly in normal animals. These teeth continue to grow and depend on constant grinding against opposing teeth to maintain their shape. If there is a malposition of the jaw, broken teeth, or malformation, overgrowth will occur in the cheek teeth similar to that which occurs in the incisors.

Signs of malocclusion are gradual loss of appetite and weight. Both sides of the mouth may become stained and saliva. Animals become progressively listless, dehydrated, and unable to chew properly. Complications are abscessed teeth, growth of teeth into the upper jaw, and death from starvation.

Malocclusion of the incisors can be corrected temporarily by cutting back the teeth so the animals can eat and attain good condition prior to slaughter. Since malocclusion is inherited, it can be eliminated by selective breeding.

## 17. Splay Leg and Ataxia

Splay leg in rabbits is due to a simple recessive genetic factor. The disease is characterized by an inability to put weight on one or both hindlegs, and may even involve all 4 limbs. The limbs are twisted so that the rabbit exhibits a double-jointed posture. The rabbits are not paralyzed. They eat normally, appear to be well, and move wriggling along on their belly and chest. The pathologic effects are limited to the hip and shoulder.

Ataxia (muscle incoordination) resembles splay leg in some respects. It is, however, a lethal recessive genetic factor. The disease usualy appears when the rabbit is 2-3 months of age and runs its course in 30 days. In ataxia, the nervous system is involved, and at first the rabbit may not be able to use its hindlegs effectively. Later the rabbit cannot move, and its body temperature drops below normal until death ensues.

## Rabbit Parasites

Volunteers working in the field with rabbits should place more of their energies and resources on prevention of rabbit parasites, rather than on expensive chemical cures. As we have said repeatedly, prevention of both diseases and parasites (through good husbandry skills) is far more valuable than cure. Chemical "cures" are often unavailable, expensive, and of only short-term value. The key to parasites is knowing their life cycle so that you can plan to disrupt it and thereby remove them from rabbits in the least expensive manner. 90% of prevention of rabbit parasites depends on good sanitation and a good, balanced feed ration.

### Internal Parasites

### 1. Coccidia

Coccidiosis is the prevalent parasitic disease of domestic rabbits. It is caused by a microscropic parasite that invades the lining of the intestine or liver. In these locations, the parasite multiplies extensively, and then leaves the body in the feces. Rabbits that recover from this protozoan infection frequently become carriers. It is important to distinguish between liver coccidiosis and intestinal coccidiosis. At least 4 species of coccidia live in the intestine, and 1 species grows in the liver.

Not all species of coccidia are equally harmful, and rabbits tolerate moderate numbers of some without illness. The most dangerous of the intestinal forms are Eimeria magna and E. irresidua. These produce symptoms such as diarrhea, poor appetite, weight loss, and sometimes death. E. irresidua evokes the most severe tissue damage. In some cases, direct damage may occur to the intestinal wall. The clinical diagnosis of coccidiosis depends on finding the oocysts in the feces or intestinal contents. Field diagnosis depends on live and post-mortem identification of the symptoms. Diagnosis of live animals is often difficult because other diseases and disorders produce similar symptoms.

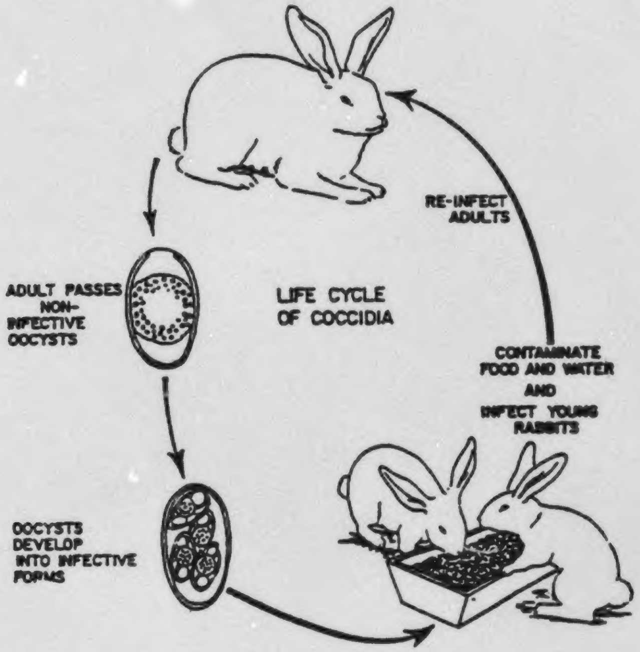
Control of intestinal coccidiosis depends largely on management practices that minimize the danger of fecal contamination of feed, water, and hutch floors. Wire bottom floors greatly reduce the hazard presented by solid floors or slots. Feeders should be designed so that fecal contamination is held to a minimum. This is best done by building a feeder that the rabbits cannot sit in. An automatic water system (bottle and can) is recommended. Oocysts passed in the feces require moisture and warmth to sporulate and become infective. Therefore, coccidia are more widespread in the humid tropics than in other climatic zones. Dry wire floors and automatic water systems hinder sporulation of the parasite.

Sulfaquinoxaline administered continuously in the drinking water (0.025% for 30 days) prevents the development of the clinical signs of hepatic (liver) coccidiosis in rabbits heavily exposed to E. stiedai. Sulfaquinoxaline may also be given in the feed at 0.025% for 20 days, or for 2 days out of every 8, until slaughter. The rabbits acquire an immunity to subsequent infections. Lower concentrations of the drug are not satisfactory. The maximum prophylactic effect is obtained by 3 weeks of administration. A concentration of 0.10% of sulfaquinoxaline in the feed, or 0.05% in the feed and 0.04% in the drinking water, given continuously for 2 weeks, is recommended for therapeutic control of naturally occurring outbreaks. The drug should not be given within 10 days of slaughter of the rabbits. Sulfametazine, sulfamerzaine, or succinyl-sulfathiazole in the feed at 0.5% concentration have also been used during outbreaks

Treatment has only a temporary effect on intestinal coccidiosis, but may be useful in controlling outbreaks. When needed, a ration containing 0.1% sulfaquinoxaline may be fed continuously for 2 weeks. Intestinal coccidia develop a tolerance to the drug if it is used continuously, so treatment is not suggested unless clinical symptoms appear.

E. stiedade, the one species of coccidia that multiplies in the liver, is considered to be the most pathogenic coccidia of rabbits. Like the other forms, it enters the intestinal wall, but migrates to the bile ducts, where it reproduces. Infections lasting more than 16 days can be recognized by the white, circular nodules of the liver. The coccidia multiplies in the epilthelial cells of the bile ducts, which become thickened and tortuous and contain a vast number of occysts. In the early stages of infection there are no unusual symptoms, then the appetite decreases, a potbelly develops, and sometimes death follows. In moderate infections, there is no mortality, but disfigurement of the liver will occur.

Liver coccidiosis is acquired in the same manner as intestinal coccidiosis. The control measures also similar; however, liver coccidiosis can be controlled more easily by proper management.


LIFE CYCLE
OF COCCIDIA
RE-INFECT ADULTS
ADULT PASSES NON-INFECTIVE OOCYSTS
OOCYSTS DEVELOP INTO INFECTIVE FORMS
CONTAMINATE FOOD AND WATER AND INFECT YOUNG RABBITS

### 2. Nosema

Nosema cuniculi is the cause of this mild but longstanding disease in rabbits. Many apparently healthy animals may have kidney lesions related to this infection. These lesions include cortical scarring with multiple, indented gray areas on the surface of the kidney. The scars extend from the cortical surface to the medulla. Nosematosis is a contagious colony infection. The organisms are passed in the urine and transmitted when there is urinary contamination of feed or water. Transmission may also occur to unborn rabbits in the uterus when the doe has the disease. The disease can be controlled by providing good sanitation and preventing contamination of food and water by urine. No treatment is available.

### 3. Roundworms

Roundworms (ascarius) are slender and cylindrical. They are found in the digestive tract. The stomach worm is a very slender, reddish worm about 1/2 inch long. Trichuris strongylus--the whip worm--is about the same size but is found in the small intestine. Both have similar life cycles. Eggs are passed in the feces, and after a short period small infective larvae develop. Moisture and warmth favor larval development; larvae are ingested and pass to the stomach or small intestine where they grow into adults.

Signs of infection depend on the degree of infestation. Light infestations produce little effect; heavy infestation may cause diarrhea and emaciation. The stomach worm produces ulceration of the stomach wall. Rabbits kept on the ground are more apt to be exposed to parasites than those kept on wire. Control can be accomplished by proper sanitation.

### 4. Pinworm

The pinworm, Passalurus ambiguus, is a common parasite of rabbits. These worms are glistening, white, and 1/2 inch long. They are often seen on the surface of freshly passed feces or through the wall of the cecum when animals are slaughtered. Ordinarily, pinworms do little harm. As the mature worms become inactive, they are passed out of the cecum as fecal pellets are formed. These parasites are spread from animal to animal by ingesting feed and water contaminated by the droppings of infected animals. Management methods used to control coccidiosis are effective against pinworms. When treatment is necessary, piperazine citrate is effective when administered at 100 mg/100 ml drinking water for one day. Also, phenothiazine may be mixed in the feed at a 2% strength.

### 5. Tapeworm

Tapeworms occur in rabbits as adults in the intestine and as larval forms in the liver and abdominal cavity. The adult forms are very rare in hutch-raised rabbits (they are fairly common in tropical zones where rabbits are raised on dirt floors) but larval forms are more common.

The rabbit tapeworm, Cittotaenia ctenoides, is flat, ribbon shaped, and made up of numerous segments. It has a head with 4 suckers with which the worm attaches to the lining of the intestine. Rabbits harboring a few tapeworms show no signs of disease. When many tapeworms are present, diarrhea and emaciation occur. Control is readily accomplished by good sanitation.

The most common larval forms of tapeworm are those of Taenia pisiformis. They are fond in the abdominal cavity and in the liver. Rabbits acquire these tapeworms infections by eating contaminated feed and drinking contaminated water containing tapeworm segments and eggs from the feces of dogs. The young larvae are then released from the eggs, penetrate the digestive tract, and migrate to the liver. They migrate within the liver, leaving white streaks behind, then leave the liver and enter the abdominal cavity. They then form small fluid-filled cysts (cysicerci), which may be attached to the membranes holding the intestinal tract or may exist free in the abdominal cavity. Each cyst contains an embryonic tapeworm, which, when eaten by a dog, will develop into a mature tapeworm. Dogs should not be allowed near rabbits nor allowed to eat any part of a raw rabbit carcass. Treatment for larval stages in the rabbit is not practical so control must be accomplished by management.

## External Parasites

### 6. Ear Mite (Mange)

Psoroptes cuniculi, the common ear mite of rabbits, causes ear mange or canker. This condition is probably the second most common parasitic disease in rabbits. It is surpassed only by coccidiosis in terms of the damage it causes. Both can occur in well-managed colonies that are housed on wire floors as well as those raised on solid floors.

The mites live in the ear canal and cause damage to the skin lining this area. An exudate of brown, waxy material soon covers the inner ear. This dark encrustation consists of cellular debris, keratin, dried blood, and mites in varying stages of development. In severe cases, the entire inner surface of the external ear may be involved.

An effective medicine for ear mange is made of 1 part kerosene and 2 parts vegetable oil. Lindane (benzene-hexachloride) is also effecive when used as a 0.25% suspension in oil. Mineral oil by itself may also be used. If an outbreak occurs, first treat all rabbits in the colony. Start with those rabbits showing few signs of disease and finish with those having severe infections. This will minimize spreading of the parasite. Swab the entire inner ear with the oil mixture on a cotton swab or a piece of cloth. Allow a small amount to run down into the ear passage. If scales or crusts are sparse, be sure to work the oil well into the ear. If heavy crusts are present saturate them with oil until they become soft, and then remove them with tweezers. Then medicate the ear again. Burn all the cotton swabs and material removed from the ear.

Ear mange can be treated and eliminated from colonies by rigidly following the above treatment program. However, all rabbits must be treated, and all new introductions to the colony must be free of mites to keep the condition from reoccurring. Psoroptes cuniculi, Notoedres cati, and Cheylcticella parasitovorax may also cause mange on the skin of the head and body in rabbits. These parasites may cause the skin to become dry, scaly, irritated, and itching with hair loss in affected areas. Treatment is by dusting with talc containing 0.25% lindane.

### 7. Cuterebrid Flies

Larvae of Cuterebra flies are common subcutaneous parasites of wild rabbits but infrequent parasites of domestic rabbits. The adult fly appears wherever populations of wild rabbits exist. Rabbits are infected when the fly deposits eggs on the fur. Grub worms hatch from these eggs and burrow into the skin to form warbles. The larvae grow under the skin and may get as long as three-quarters of an inch. When full grown, the grubs leave the skin, drop to the ground, and develop into flies. The warbles cause little trouble when they are found in small numbers. The larvae can be removed by enlarging the opening in the skin and drawing them out with tweezers. The wound should then be painted with an antiseptic (such as iodine).

### 8. Fleas and Ticks

Rabbits are not commonly infested with fleas, but the rabbit flea, Spilopsyllus cuniculi, and the dog and cat-fleas Ctenocephalides canis and C. felis, occasionally have been reported on rabbits. These are more common when rabbits are not raised on wire floor cages--especially in the tropics. There are 4 stages in the life cycle of these fleas--egg, larva, pupa, and adult. The eggs are deposited on bedding and in cracks of the nestboxes and develop into larvae in a short time. These larvae then form pupae from which the adult fleas emerge. Control is aimed at killing the adults on the host and the immature forms in the nestbox. To destroy adult fleas, dust the animals with a commercial preparation of pyrethrum, rotenone, sevin, or malathion. Dusting should be repeated several times during a 2 week period. When dusting with malathion or sevin be sure to work the insecticide in past the fur to skin and avoid the head and eyes. Immature forms can be controlled by burning old nest box litter and scrubbing nestboxes with hot water and bleach.

The rabbit tick, Haemaphysalis leporispalustris, is a common parasite of wild rabbits and is less common on domestic rabbits because their housing is often not compatible with the life of the tick. However, this tick is one of the reservoirs of tularemia. This is a serious human disease, and care should be taken to insure that wild rabbits are not allowed access to areas in which domestic rabbits are being raised.

## Noninfectious Conditions of Rabbits

### 1. Mucoid Enteritis (Diarrhea)

Diarrhea is one of the major killers of rabbits between birth and weaning. It is not common until the fourth week of age, peaks at 7 weeks, and declines sharply after the eighth week. It is unimportant after 16 weeks.

Generally, sick rabbits lose their appetites, have a hunched appearance with dull, squinted eyes, and have diarrhea of varying intensity. The fur loses its sheen, and the coat becomes rough. Rectal temperature may be normal (102.5) or subnormal. As diarrhea and dehydration progress, the rabbit may lose 20 to 25% of its body weight in 24 to 48 hours. The course of the disease may end in death after 24 to 72 hours following acute signs. In the chronic phase, the rabbits may live for 4 to 10 days. In general, 95% of the mortality has occurred by the sixth day. Not all cases end in death; however, less than 50% recover, and these generally prove unprofitable because of weight loss and poor feed conversion.

Pathologic changes are confined to the gastrointestinal tract. The small intestine may show only increased mucus production. In chronic or subacute cases, the cecum and large intestine may be packed with a clear, thick gelatinous substance. Acute cases show excess fluid in the intestine. Varying degress of gastritis are noted when the stomach is distended with fluid. Other viscera are not affected expect through secondary infection. Pneumonia is a frequent complication.

The cause of mucoid enteritis is obscure and probably complex. Diet has been implicated; however, extensive research using different combinations of cereal grains, plant protein supplements, vitamins, minerals, legumes, and carbonaceous hays have led to the conclusion that the kinds of food used were not primary factors in preventing, causing, or curing the disease. Diet may be implemented in the multiple causation theory of the disease.

Several bacterial species have been isolated from affected rabbits, but their importance is difficult to assess. Coliform bacilli and anaerobic bacteria have been isolated, but these are normally present in the intestine, and their pathogenicity has not been proved.

Limited attempts to isolate a virus or to transmit one have failed. Coccidiosis is often found in animals with enteritis, but their presence is probably not related to the disease.

Unfortunately, there is no specific treatment for diarrhea. Culling and slaughter of infected animals may be your only choice. Chlortetracyclines and oxytetracycline added to feed or water have been effective in reducing loss. Where appropriate, these antibiotics may be fed to does during the entire sucking period.

## 2. Wet Dewlap

Some rabbits have a heavy fold of skin on the ventral aspect of the neck. As the rabbit drinks, this skin may become wet and soggy leading to inflammation of the area. Damp bedding and dental malocclusion can aggravate this condition. The hair may slip and the area may become infected. To prevent this, the waterers should have small openings or be set low on flat boards. The hair in the affected area must be clipped and an antiseptic dusting powder applied.

## 3. Cannibalism

Most cases of cannibalism are the result of either the diet being inadequate in either quality or quantity, a lack of water, or because the doe was disturbed following kindling. Proper feeding and seclusion at kindling will usually prevent this tendency. A doe that destroys her first litter should be given another chance. If she continues, she should be culled from the breeding population. General stress of the doe (such as handling the young before they reach 2 weeks of age) can contribute to cannibalism as well.

## 4. Heat Prostration

Heat prostration results from prolonged exposure to excessive heat. Losses may be high in females about to kindle or in infant rabbits if the nestboxes are poorly ventilated. Just before dying, the animals breathe rapidly and become comatose. Free access to water and salt blocks will help to prevent this condition. Adult rabbits suffering from the high heat and/or humidity may be relieved by spraying them with water, placing a wet burlap feed sack on the cage floor, or dipping them in a bucket of cool water. In locations subject to high temperatures burlap sacks soaked in water can be hung from the edges of the roofs to shade and cool the air. Hutches should also be designed so that they can be sprinkled during high temperatures.

## 5. Broken Back

This condition is characterized by sudden paralysis with no apparent cause. Paralysis extends from the middle of the back with complete paralysis from this point back. The rabbit moves with its front legs and drags the hindquarters. The urinary bladder may become greatly distended. Paralyzed animals have a misplaced or slipped vertebra. Malposition of the vertebra may be caused by improper handling or by injuries occurring at night when predatory animals invade the rabbitry. In an effort to protect the young and evade the predator, the buck or doe "stamps" firmly with its hindfeet. As result the vertebra becomes misplaced and the spinal cord is damaged. There is no treatment, and the injured rabbit should be killed.

## 6. Sore Hocks

Sore hocks are inflamed bare spots of fur, found on the bottom surface of the hind legs. In more severely affected cases, secondary infections with staphylococcus and abscesses occur. It is caused by the pressure on the skin (due to the weight of the rabbit) on wire floored cages. As the hocks of the hind feet become painful, the rabbit throws more weight onto the front feet and causes them to become affected. Wet, dirty hutch floors and the irritating action of urine ammonia are predisposing factors. The breed of the rabbit is also a factor in the development of sore hocks as the disease is seen more often in large breeds as compared with smaller breeds due to their weight. Affected rabbits may otherwise appear healthy or suffer a loss of appetite, weight loss, and/or death. Treatment consists of using solid-bottom cages with clean, dry bedding and topical application of an iodine ointment.

## 7. Dystocia

The gestation period of the rabbit rarely exceeds 32 days. If a pregnant doe is overdue and is straining or in distress, an injection of oxytocin is generally effective. 1 or 2 u. of oxytocin should be given by subcutaneous or intramusclar injection.

## 8. Fur Eating and Hairballs

Several rabbits in a hutch may eat body fur, eyelashes, and whiskers. Single rabbits eat fur on their sides, back, and rump. The cause is most likely improper diet; however, sometimes it appears to be a vice. Fiber deficiency or inadequate protein may be factors. A 15% fiber level is probably the minimum that should be fed to either growing or producing rabbits. Rabbits may also eat small amounts of hair by licking or grooming themselves. The hair may accumulate in the stomach and form hairballs. These cause no diseases, normally, but they may obstruct the stomach. When obstruction occurs, the rabbit quits eating, loses weight, and may die. Rabbits that develop this habit are difficult to break of it and you may wish to cull them from your colony. Mineral oil given by stomach tube is the only practical means of treatment possible and it is probably not practical where animal care facilities are minimal or nonexistent.

## 9. Coprophagy

The process of taking soft fecal pellets from the vent and swallowing them intact is a natural physiological habit for the rabbit that should not be misinterpreted as a nutritional condition or depraved appetite. Coprophagy is practiced at night by tame rabbits and during the day by wild rabbits in their burrows. Fermentation of the feces in the large intestine supplies an abundance of certain B vitamins to the fecal pellets, and improves fiber breakdown by bacterial action. By permitting a second passage of food through the digestive tract, the rabbit gains additional nutritive value from the feed.

## 10. Yellow Fat

Yellow fat is not an abnormal condition nor the result of an infectious process. It is included here only to prevent misunderstanding or association with a disease condition. Yellow fat is a genetic trait determined by a recessive gene. Alfalfa and other green feeds contain xanthophyll, a fat soluble compound that is yellow in color. Rabbits with the yellow fat gene lack an enzyme that changes the xanthophyll pigment to a colorless product. Therefore, the xanthophyll pigment is deposited in the body fat making it yellow. The only concern that you, as a volunteer in the field, would face is local preference in the color of the body fat.

## Rabbit Genetics

### Breeds

Rabbits, unlike swine, poultry, and goats, cannot be allowed to free-range even at low levels of production. One result of this physical limitation is that a wide variety of local breeds of rabbits have not been developed in third world countries. There are a few local breeds (such as the Baladi which are raised in Sudan) but these are not to be confused with wild rabbits. Wild rabbits harbor diseases and parasites which are transmittable, in many cases, to domestic rabbits. It is a mistake to attempt to domesticate wild rabbits or use them in your rabbit projects. They have difficulty even surviving in captivity, much less being productive. Therefore, unless you have a local breed of rabbit which has been domesticated and produces well in your area, you will need to select an exotic breed of rabbit to use as the breeding stock in your project.

Since no single breed is appropriate in all situations I will offer to you some criteria to consider in choosing a particular breed over another.

1. At what level of production (survival, moderate, or high) will you be working?
2. Do you need rabbits that are good survivors and will receive minimal care or do you need production breeds that produce well under good management?
3. Are there cultural preferences locally as to the size or coloring of rabbits? (White rabbits, for example, are often seen only as pets.)
4. Are you raising them for meat or for fur?
5. What size of rabbit will you be trying to sell?
6. Which different breeds are available locally? Why?
7. Is there any preference, locally, concerning the taste or color of rabbit meat?
8. What quality and quantity of feeds do you have available?

Listed below are some of the more than 30 exotic breeds (which does not include the approximately 100 different varieties) which exist. The breeds listed below are some of the more common breeds used in production worldwide. The breeds listed have been grouped according to their mature weight as either small or dwarf breeds, medium sized breeds, or large/giant breeds.

### Small or Dwarf Breeds

These breeds weigh only 3 to 4 pounds at sexual maturity. They are not commonly used because of their reduced size which reduces their acceptance as a marketable meat animal. They do have the benefit of reduced energy requirements for maintenance because of their small body size, however.

1. Dutch

These smaller rabbits are pictured below and are grown in Tanzania.

2. Criollo

This rabbit is common to Mexico and Central America. It has a small body size and relatively low production characteristics but is hardy and tolerant of local conditions.

3. Polish

These rabbits are exceedingly small and never weigh over 3-1/2 pounds.

## Medium Size Breeds

These breeds will weigh 9-12 pounds at maturity. They are the most common size of rabbit used for commercial production worldwide. Nowhere has a particular breed of rabbit been selected and specifically developed for tropical conditions. Generally, developing countries use the medium size breeds developed in Europe which adapt well to backyard tropical conditions.

1. Californian

This is one of the more common breeds available worldwide. It is similar in size and disposition to the New Zealand White. The dominant marking of the Californian is its brown ears.

2. New Zealand Whites

The New Zealand White was developed for intensive systems in Europe but has also adapted very well to the tropics. It is probably the most common exotic breed available worldwide. It can be found in Mexico, Central America, Tanzania, Mozambique, Mauritius, Nepal, and other countries. Since it is such a popular breed, there are plenty of sources of good quality stock available worldwide.

## Large or Giant Breeds

1. Flemish Giants

Popular in Ghana and available, generally, in West Africa, these rabbits can weigh more than 13 pounds when mature.

2. Checkered Giants

Also raised in Ghana, it is preferred there even though it has inferior production characteristics to those of smaller breeds available. Its popularity seems to stem from its size and color.

### 3. Yellow Silvers

This large breed (12-14 pounds) is also a favorite in West Africa.

## Breeding or Mating

Read pages 23 to 25 of Raising Rabbits by VITA for an explanation of the mating process. I would only add that rabbits are very territorial and will not mate if they feed stressed or threatened. It is best to mate rabbits during the cool of the day when libido and sperm fertility are at their highest. In the hot tropics, temperatures over 30°C. can depress reproduction.

Refer to the following charts for information on breeding systems and rabbit life cycle.

## Crossbreeding

When different breeds of rabbits are crossed the result is hybrid vigor. You may find it appropriate to cross exotics with local breeds of rabbits in order to produce an animal with some production characteristics and some survival characteristics. This is not a good idea if you are striving for high production but it may be appropriate in low to moderate production environments where disease and parsites are still a problem and the feed available is not expensive, highly nutritious feed. However, in making your decision on this issue consider the following points:

**Advantages:**

1. As mentioned, your rabbits may gain hybrid vigor and couple good survival characteristics with production.

2. You can improve the bloodline of local breeds of other farmers in the area.

3. One exotic buck can service many local breed does.

**Disadvantages:**

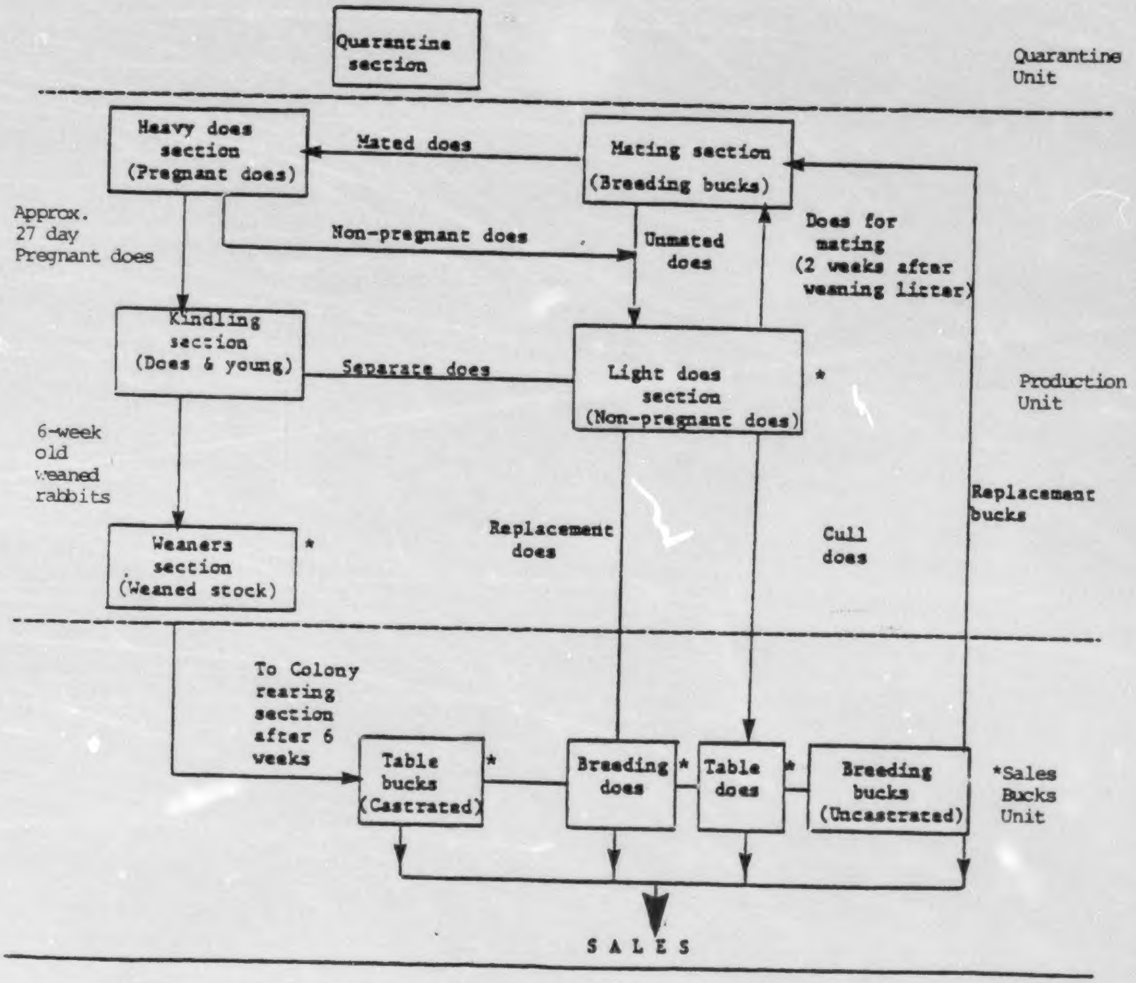
1. By mating your buck with the does of local breeds, you are exposing the buck to diseases and parasites that are in the other colony. Before using your buck for breeding purposes outside your colony, be sure to check out the health of the colony that the doe came from.

2. Quarantine all new does or bucks brought into your colony for breeding until you can be sure that they are disease and parasite free.

## Inbreeding

Inbreeding within the bloodlines in your colony can couple recessive genes that produce characteristics not desirable in a production rabbit. Good management and recordkeeping are your tools to prevent inbreeding.

Illustration 3-4



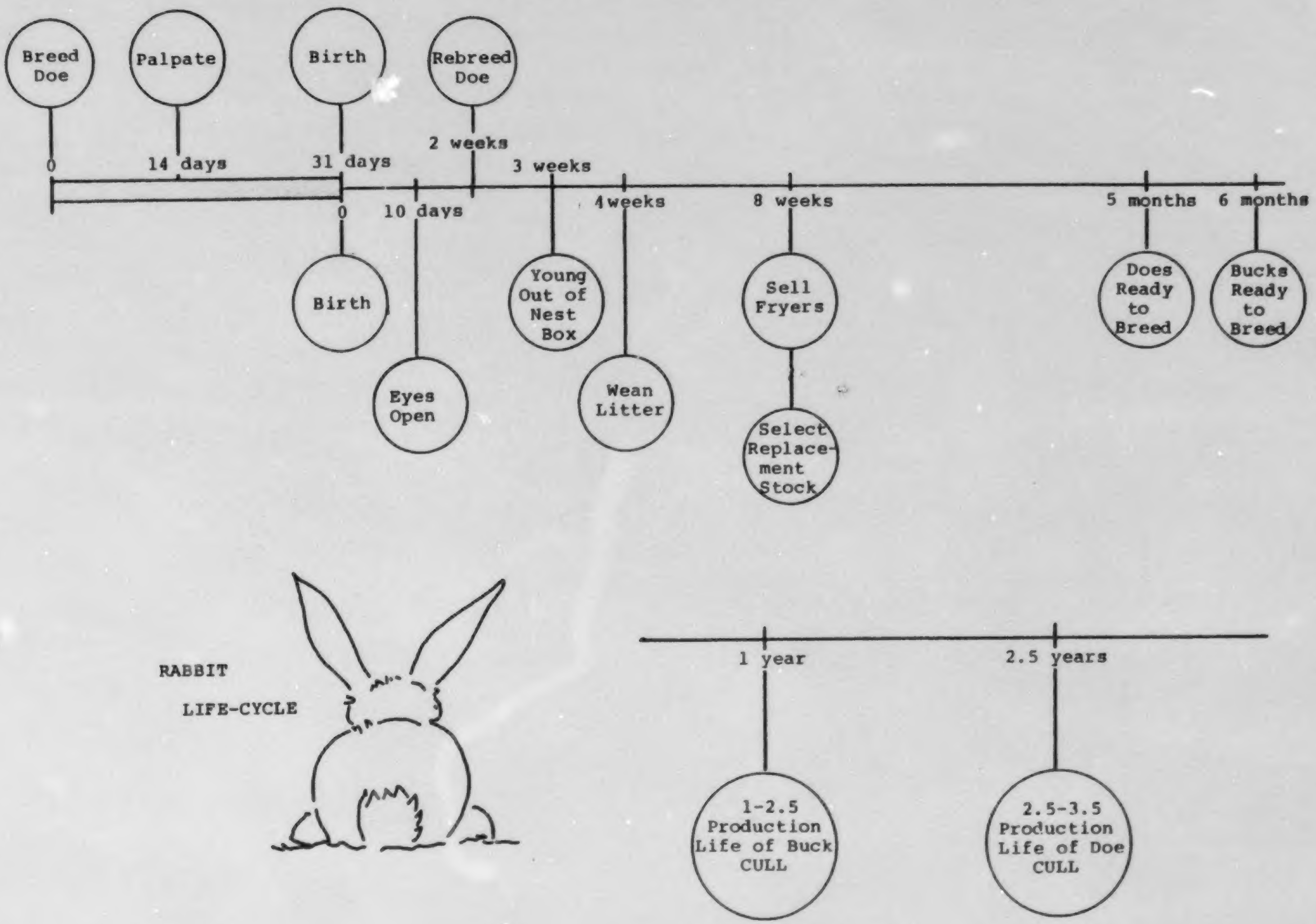
Quarantine section
Quarantine Unit
Heavy does section (Pregnant does)
Mated does
Mating section (Breeding bucks)
Approx. 27 day Pregnant does
Non-pregnant does
Unmated does
Does for mating (2 weeks after weaning litter)
Kindling section (Does & young)
Separate does
Light does section (Non-pregnant does)
*
Production Unit
6-week old weaned rabbits
Weaners section (Weaned stock)
*
Replacement does
Cull does
Replacement bucks
To Colony rearing section after 6 weeks
Table bucks (Castrated)
*
Breeding does
*
Table does
*
Breeding bucks (Uncastrated)
*Sales Bucks Unit
SALES

Commercial rabbit breeding system used in Isito, Ghana involving colony housing of certain classes of adult stock.

*/ Signifies that the rabbits are kept in groups.

Source: Odonkor (1978).

Illustration 3-5


Breed Doe
Palpate
Birth
Rebreed Doe
0
14 days
31 days
2 weeks
3 weeks
0
10 days
4 weeks
8 weeks
5 months
6 months
Birth
Eyes Open
Young Out of Nest Box
Wean Litter
Sell Fryers
Select Replacement Stock
Does Ready to Breed
Bucks Ready to Breed
RABBIT
LIFE-CYCLE
1 year
2.5 years
1-2.5 Production Life of Buck CULL
2.5-3.5 Production Life of Doe CULL

## Housing and Equipment

In attempting to alter traditional methods of raising livestock and increasing production, housing (as a component of animal husbandry) is normally a minor concern for such animals as swine, poultry, and goats. This is not the case, however, for rabbits. Rabbits are sensitive animals and are clearly outside of their normal climactic zones when placed in the hot and/or humid tropics. However, problems with climate can be adjusted for through cage design. Sunlight and good ventilation are important to the health of the rabbit and should be considered in designing a cage. The morning sun is needed by rabbits often to warm them after the cool nights and to dry the cage. Furthermore, it is important to consider the use of locally available materials in the construction of cages. Bamboo and wood can be used for the side and tops of the cages but (self-cleaning-1/2 inch grid) wire should be used when it is possible and appropriate for the floors. Clearly, wire cage floors are not always practical due to the expense and unavailability. You should remember, though, that rabbits placed on cement, bamboo, wood, or dirt floors and allowed to be in contact with their feces and urine are more prone to disease than those on wire floors. Protection from the cold (during the rainy season), heat (during the dry season and especially during the afternoon), rains (it is very important that rabbits be kept dry), and drafts should also be considered in your design. Remember, it is very important not to invest more money in your cages than can be regained through the profit of raising rabbits. For information about raising rabbits on the ground, read the article by Mark Freudenberger "Rabbits in Africa's Upper Volta." For precise cage designs appropriate to developing countries, check your VITA book. The VITA book also has some good designs for waterers and feeders that can be made from aluminum cans and bottles. Clay vessels may be substituted for the cans if they are more appropriate to your area. For such equipment your first concerns should be how well they function and how inexpensive they are.

### VITA page listings by topic

| | | |
|---|---|---|
| 1. | Construction of cages | Pages 55-79 |
| 2. | Construction of kindling boxes | Pages 26-27 |
| 3. | Hutch and equipment (waterers and feeders) designs | Pages 8-14 |

Magazine Article
Rabbits in Africa's Upper Volta

# Rabbits in Africa's Upper Volta

by Mark Freudenberger
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One of the major problems confronting rabbit raisers in developing countries is the need for low-cost, durable and effective rabbit shelters. While most rabbit producers strongly recommend that rabbits be raised in well-ventilated cages, in many countries the lack of investment capital and readily available construction materials precludes the use of wire cages.

Raising rabbits in well-ventilated cages is admittedly the most practical, sanitary and efficient production method. I recommended this system in Togo when I was there introducing rabbit raising in the primary schools.

Togo, several types of durable, lowcost cages were designed using locally available materials such as bamboo and palm tree slats, teak branches and cord as fasteners. Given the plentiful supply of wood and the low cost of most other construction materials there, the use of cages was certainly advisable in the humid tropids.

In the dry regions of Upper Volta, however, economic and environmental conditions preclude the construction of inexpensive rabbit cages, and traditionally rabbits are raised in enclosures on the ground. In the Sudano-Sahelian zones, the cost of building cages is prohibitively high. Good quality wood is difficult and expensive to buy, while local wood rarely provides straight sticks and branches that could be used to build homemade cages. Most construction materials, such as wire mesh or nails are imported at a high cost and are only available in large urban centers.

Given the problems of obtaining materials to build cages, it is most advantageous for low income people to raise rabbits on the ground. Unless a rabbit raiser has sufficient money to begin a commercial operation, there are few alternatives.

The construction of a rabbit cage made of wire mesh and wooden braces is about $20 per rabbit, or roughly the weekly salary of a primary school teacher in Upper Volta. Few farmers, rural based school teachers, or students have the financial means to invest this sum in cage construction, nor do they have ready access to wire mesh, wood or carpentry tools.

Given these limitations, most rabbit producers have constructed small mud huts with grass roofs in order to house their rabbits on the ground. Male and female rabbits are allowed to run free in the building, while young are kindled in holes dug by the does, or in small enclosures built out of mud jars, mud bricks or old cardboard boxes.

Provided the hut is kept clean and the rabbits are fed sufficiently, production is fairly high. Farmers in the Tenkodogo region of east-central Upper Volta have used this method since the introduction of domestic rabbits by the French colonialists. However, farmers report that losses of young are frequent, often due to cats and rats entering the rabbit nests and sometimes due to trampling by the rabbits themselves if conditions become too overcrowded.

Through the auspices of a primary school agricultural education project funded by Catholic Relief Services, the following changes have been made in an effort to improve the traditional method of rabbit production.

At each rabbit project, two to three round huts measuring 3.5 meters in diameter and 1.75 meters in height are constructed by villagers. A local mason pours a thin layer of concrete on an inward sloping floor. A trough through the middle of this floor is constructed as a channel for urine and the water used to wash the floor every week. This trough leads outside to a clay jar that collects the waste materials for the school garden compost pile. Ventilation is insured by the provision of two large windows and a partially screened door.

Rabbits are allowed to roam freely outside in a mud-walled enclosure. Around the walls of the huts, covered tunnels made of mud brick are employed as rabbit nests and shelters. Enough "caverns" are constructed to house each female rabbit. All does are housed in one hut with their unweaned young. The weaned young and the males are kept in the other two huts. When mating is to occur, the does are simply placed among the males, either for a few minutes, or overnight.

An alternative method practiced successfully in the Fada N'Gourma region of Upper Volta is to make cages for the breeding males, yet let all other rabbits run freely.

The total investment for this on-the-ground system which can house about 30 rabbits is approximately $50. Compared to the cost of $20 per cage, a person using the on-the-ground method must only buy three sacks of cement and several doors and windows, all available locally.

Other small improvements are possible. Feeding practices may be improved by making small mangers for grass, or tying grass together with a wire and hanging it from the roof. This prevents rabbits from defecating on their feed. Small clay bowls could be made by local potters for use as waterers. Large tin vegetable oil containers can be cut and shaped to make feeders that prevent spilling.

While on-the-ground rabbit raising has many potentialities, several limitations should be noted. It is only an adequate system for regions with long dry seasons. In the more humid tropics, continuous humidity and rainfall will eventually begin to affect the living conditions in the rabbit huts. The use of local West African rabbits also may insure their survival, as purebred rabbits could probably not tolerate the somewhat unhygienic conditions. Obviously, controlled breeding and careful record keeping is difficult when raising rabbits on the ground, and ultimately, if the huts are not kept clean, dry and well-protected from predators, rabbits will not survive.

But despite these limitations, on-the-ground rabbit raising in Upper Volta is one of the few alternatives available for the low income population. With small improvements this type of rabbit production may become more productive, though it is doubtful that it can ever be as intensive as raising rabbits in cages.

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# POULTRY NEEDS AND NUTRITION

This section of the guidlines is a supplement of Chapter 8, Feeds and Nutrition from Peace Corps ICE Manual M-11, PRACTICAL POULTRY RAISING. This section introduces another method of computing a feed ration. Since people have different methods of learning, it is felt that it is necessary to include alternative styles of doing and solving problems. The objective of this session is for trainees to learn how to do a poultry feed ration. Since nutrition and feeds are probably the most important component in livestock production, learning to mix feeds is a valuable learning tool.

The Trainee learns:

1. The nutritional values and deficiencies of different feed ingredients.
2. Problem solving skills through trial and error, and resource finding/utilization.
3. How different parts of a whole are integrated (e.g., changing one ingredient effects the nutritional value of the whole ration).

The method of learning how to do a ration is analysis of an example and looking at part of it in a step-by-step fashion.

# TABLE A

## REQUIREMENTS FOR POULTRY

| | ME | CP | P | Lysine | Ca |
|---|---|---|---|---|---|
| 1 Broiler (0-3 weeks) | 3200 | 23 | .7 | 1.2 | .9 |
| 2 Broiler (3-6 weeks) | 3200 | 20 | .7 | 1.0 | .9 |
| 3 Broiler (6-9 weeks) | 3200 | 18 | .7 | .85 | .9 |
| 4 Pullets (0-6 weeks) | 2900 | 18 | .7 | .85 | .9 |
| 5 Pullets (6-14 weeks) | 2900 | 15 | .4 | .60 | .6 |
| 6 Pullets (14-20 weeks) | 2900 | 12 | .4 | .45 | .6 |
| 7 Laying hens | 2850 | 15 | .5 | .60 | 3.25 |
| 8 Breeding hens | 2850 | 15 | .5 | .60 | 2.75 |
| 9 Ducks (growing) | 2900 | 16 | .6 | .90 | .6 |
| 10 Ducks (breeding) | 2900 | 15 | .6 | .7 | 2.75 |
| 11 Geese (0-6 weeks) | 2900 | 22 | .6 | .9 | .8 |
| 12 Geese (After 6 weeks) | 2900 | 15 | .4 | .6 | .6 |
| 13 Geese (Breeding) | 2900 | 15 | .6 | .6 | 2.25 |

TABLE B

## —Calcium and Phosphorus Sources Available for Poultry Feeding

| *Mineral sources* | *Calcium* % | *Phosphorus* % |
|---|---|---|
| Bone meal, special steamed | 29 | 14 |
| Bone meal, steamed | 24 | 12 |
| Bone charcoal | 27 | 13 |
| Calcium carbonate | 40 | — |
| Calcium phosphates: | | |
| Monocalcium phosphate, $CaH_4(PO_4)_2\ H_2O$ | 16.9 | 24.6 |
| Dicalcium phosphate, $CaHPO_4 \cdot 2H_2O$ | 23.3 | 18 |
| Tricalcium phosphate, $Ca_3(PO_4)_2$ | 38.8 | 20 |
| Dicalcium phosphate; feed grade | 24–28 | 18–21 |
| Curaçao Island phosphate | 35 | 15 |
| Defluorinated rock phosphate | 33 | 18 |
| Soft (colloidal) phosphate | 15–18 | 9 |
| Sodium phosphate monobasic, $NaH_2PO_4 \cdot H_2O$ | —— | 21.8 |
| Limestone | 33–38 | — |
| Oyster shell | 37–39 | — |
| Phosphoric acid, feed grade 76% pure | — | 24 |

## Characteristics of Grains Used in Poultry Feeding

| | | *Metabolizable energy* | | | |
|---|---|---|---|---|---|
| *Grain* | *Bushel weight lb* | *kcal/lb* | *kcal/kg* | *Protein* % | *Comments* |
| Corn | 56 | 1560 | 3430 | 9.7 | Good source of vitamin A precursors, xanthophyll pigments and linoleic acid |
| Milo | 56 | 1480 | 3250 | 11 | May replace corn but lacks xanthophyll pigments and is lower in linoleic acid |
| Wheat | 60 | 1480 | 3250 | 10–17 | Protein content varies as to area grown. Protein content of wheat used must be known |
| Barley | 48 | 1290 | 2840 | 11.5 | Barley grown in western dry-farming areas may be improved by water or enzyme treatment |
| Oats | 32 | 1190 | 2620 | 12 | Normally too low in energy for use in poultry feeds except when low-energy high-fiber feeds are desired |

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## TABLE C-1

| Line No. | Feedstuff | International Feed No. | Dry Matter (%) | Energy (kcal/kg) |  | Protein (%) | Ether Extract (%) | Crude Fiber (%) | Calcium (%) | Phosphorus (%) | Potassium (%) | Chlorine (%) | Iron (%) | Magnesium (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  | $ME_n$ | Pro |  |  |  |  |  |  |  |  |  |
|  | Alfalfa meal, dehydrated |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 01 | 17% Protein | 1-00-023 | 92 | 1,370 | 580 | 17.5 | 2.0 | 24.1 | 1.44 | 0.22 | 2.17 | 0.48 | 0.048 | 0.38 |
| 02 | 20% Protein | 1-00-024 | 92 | 1,630 | 850 | 20.0 | 3.6 | 20.2 | 1.67 | 0.28 | 2.21 | 0.46 | 0.039 | 0.36 |
| 03 | Barley | 4-00-549 | 89 | 2,640 | 1,790 | 11.6 | 1.8 | 5.1 | 0.03 | 0.36 | 0.48 | 0.15 | 0.005 | 0.14 |
| 04 | Barley, Pacific coast | 4-07-939 | 89 | 2,620 | 1,720 | 9.0 | 2.0 | 6.4 | 0.05 | 0.32 | 0.53 | 0.15 | 0.011 | 0.12 |
| 05 | Blood meal, vat dried | 5-00-380 | 94 | 2,830 | 2,280 | 81.1 | 1.6 | 0.5 | 0.55 | 0.42 | 0.09 | 0.27 | 0.202 | 0.16 |
| 06 | Blood meal, spray or ring dried | 5-00-381 | 93 | 3,420 | 2,280 | 88.9 | 1.0 | 0.6 | 0.06 | 0.09 | 0.41 | 0.27 | 0.30 | 0.40 |
| 07 | Bone meal, steamed | 6-00-400 | 97 | 1,090 | – | 12.6 | – | 4.8 | 29.39 | 12.58 | 0.09 | 0.01 | 0.32 | 0.11 |
| 08 | Brewer's dried grains | 5-02-141 | 92 | 2,080 | 1,850 | 25.3 | 6.2 | 15.3 | 0.29 | 0.52 | 0.09 | 0.12 | 0.025 | 0.16 |
| 09 | Buckwheat | 4-00-994 | 88 | 2,660 | 1,800 | 10.8 | 2.5 | 10.5 | 0.09 | 0.32 | 0.40 | 0.04 | – | 0.09 |
| 10 | Buttermilk, dried | 5-01-160 | 92 | 2,770 | 1,720 | 31.6 | 5.0 | 0.4 | 1.32 | 0.93 | 0.85 | 0.47 | 0.001 | 0.40 |
| 11 | Casein, dried | 5-01-162 | 93 | 4,130 | 2,500 | 87.2 | 0.8 | 0.2 | 0.61 | 1.0 | – | – | – | – |
| 12 | Corn, yellow | 4-02-935 | 89 | 3,430 | 2,520 | 8.8 | 3.8 | 2.2 | 0.02 | 0.28 | 0.30 | 0.04 | 0.035 | 0.12 |
| 13 | Corn, ground ear | 4-02-849 | 85 | 2,770 | 1,980 | 7.8 | 3.0 | 8.7 | 0.04 | 0.21 | 0.45 | 0.04 | 0.007 | 0.13 |
|  | Corn |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 14 | Gluten feed | 5-02-903 | 90 | 1,750 | 1,120 | 22.0 | 2.5 | 8.0 | 0.4 | 0.8 | 0.57 | 0.22 | 0.046 | 0.29 |
| 15 | Gluten meal, 41% | 5-02-900 | 91 | 2,940 | 1,850 | 41.0 | 2.5 | 7.0 | 0.23 | 0.55 | 0.30 | 0.11 | 0.040 | 0.05 |
| 16 | Gluten meal, 60% | 5-09-318 | 90 | 3,720 | 2,820 | 62.0 | 2.5 | 1.3 | – | 0.50 | 0.35 | 0.05 | 0.040 | 0.15 |
| 17 | Cottonseed meal, expeller | 5-01-617 | 93 | 2,320 | 1,520 | 40.9 | 3.9 | 10.8 | 0.20 | 1.05 | 1.19 | 0.04 | 0.016 | 0.52 |
| 18 | Cottonseed meal, solvent | 5-07-872 | 90 | 2,400 | 1,320 | 41.4 | 0.5 | 13.6 | 0.15 | 0.97 | 1.22 | 0.03 | 0.011 | 0.40 |
| 19 | Distiller's dried grains w/solubles (corn) | 5-02-843 | 93 | 2,480 | 1,960 | 27.2 | 9.0 | 9.1 | 0.17 | 0.72 | 0.65 | 0.17 | 0.028 | 0.19 |
| 20 | Distiller's dried solubles (corn) | 5-02-844 | 92 | 2,930 | 2,240 | 28.5 | 9.0 | 4.0 | 0.35 | 1.33 | 1.75 | 0.26 | 0.056 | 0.64 |
| 21 | Feather meal, hydrolyzed | 5-03-795 | 93 | 2,360 | 1,320 | 86.4 | 3.3 | 1.0 | 0.33 | 0.55 | 0.31 | – | – | 0.20 |
| 22 | Fish meal, anchovy | 5-01-985 | 92 | 2,580 | 1,890 | 64.2 | 5.0 | 1.0 | 3.73 | 2.43 | 0.69 | 0.29 | 0.022 | 0.24 |
| 23 | Fish meal, herring | 5-02-000 | 93 | 3,190 | 2,050 | 72.3 | 10.0 | 0.7 | 2.29 | 1.70 | 1.09 | 0.90 | 0.014 | 0.15 |
| 24 | Fish meal, menhaden | 5-02-009 | 92 | 2,820 | 1,980 | 60.5 | 9.4 | 0.7 | 5.11 | 2.88 | 0.77 | 0.60 | 0.044 | 0.16 |
| 25 | Fish meal, sardine | 5-02-015 | 92 | 2,880 | 1,980 | 64.7 | 5.4 | 1.0 | 4.38 | 2.58 | 0.25 | 0.41 | 0.030 | 0.10 |
| 26 | Fish meal, white | 5-02-025 | 95 | 2,570 | 1,815 | 60.9 | 3.4 | – | 5.40 | 2.60 | 1.0 | 0.52 | 0.008 | 0.22 |
| 27 | Fish solubles, condensed | 5-01-969 | 51 | 1,460 | 990 | 31.5 | 7.8 | 0.2 | 0.30 | 0.76 | 1.74 | 2.65 | 0.016 | 0.02 |
| 28 | Fish solubles, dried | 5-01-971 | 92 | 2,830 | 1,610 | 63.6 | 9.3 | 0.5 | 1.23 | 1.63 | 0.37 | – | 0.030 | 0.30 |
| 29 | Gelatin | 5-14-503 | 91 | 2,360 | 1,770 | 88.0 | trace | – | 0.50 | trace | – | – | – | 0.05 |
| 30 | Hominy feed | 4-02-887 | 90 | 2,970 | 1,890 | 10.0 | 6.9 | 6.0 | 0.04 | 0.50 | 0.46 | 0.05 | 0.007 | 0.16 |
| 31 | Limestone, ground | 6-02-632 | 98 | – | – | – | – | – | 36.23 | 0.02 | 0.12 | 0.03 | 0.341 | 2.01 |
| 32 | Liver meal | 5-00-389 | 92 | 2,860 | 2,400 | 65.6 | 15.0 | 1.4 | 0.56 | 1.25 | – | – | 0.063 | – |
| 33 | Meat and bone meal | 5-00-388 | 93 | 1,960 | 1,600 | 50.4 | 8.6 | 2.8 | 10.1 | 4.96 | 1.02 | 0.74 | 0.049 | 1.12 |
| 34 | Meat meal | 5-00-385 | 92 | 2,000 | 1,670 | 54.4 | 7.1 | 8.7 | 8.27 | 4.10 | 0.6 | 0.91 | 0.044 | 0.58 |
| 35 | Molasses, beet | 4-00-668 | 79 | 1,990 | 1,560 | 6.1 | – | – | 0.13 | 0.06 | 4.83 | 1.30 | 0.007 | 0.23 |
| 36 | Molasses, cane, dried | 4-04-696 | 91 | 1,960 | 1,540 | 7.8 | 0.5 | 6.3 | 1.10 | 0.12 | 2.60 | – | 0.095 | 0.33 |
| 37 | Oats | 4-03-309 | 89 | 2,550 | 1,810 | 11.4 | 4.2 | 10.8 | 0.06 | 0.27 | 0.45 | 0.11 | 0.007 | 0.16 |
| 38 | Oats, West Coast | 4-07-999 | 91 | 2,610 | 1,760 | 9.0 | – | 11.0 | 0.08 | 0.30 | 0.37 | 0.12 | – | – |
| 39 | Oat hulls | 1-03-281 | 92 | 400 | 220 | 4.6 | 1.4 | 28.7 | 0.13 | 0.10 | 0.53 | 0.10 | 0.010 | – |
| 40 | Oyster shell | 6-03-481 | 95 | 40 | – | 0.9 | – | – | 37.26 | 0.07 | 0.09 | 0.01 | 0.272 | 0.28 |
| 41 | Pea, seed | 5-03-600 | 90 | 2,570 | – | 23.8 | 1.3 | 5.5 | 0.11 | 0.42 | 1.02 | 0.06 | 0.005 | 0.13 |
| 42 | Peanut meal, expeller | 5-03-649 | 90 | 2,500 | 1,870 | 39.8 | 7.3 | 13.0 | 0.16 | 0.56 | 1.13 | 0.03 | – | 0.33 |
| 43 | Peanut meal, solvent | 5-03-650 | 92 | 2,200 | 1,900 | 50.7 | 1.2 | 11.9 | 0.20 | 0.63 | 1.19 | 0.03 | – | 0.04 |
| 44 | Poultry by-product meal | 5-03-798 | 93 | 2,670 | 1,980 | 58.0 | 13.0 | 2.0 | 3.0 | 1.7 | 0.30 | 0.54 | 0.044 | 0.22 |
| 45 | Rapeseed meal, expeller | 5-03-870 | 94 | 2,040 | – | 35.0 | 8.6 | 12.4 | 0.72 | 1.09 | 0.8 | – | 0.018 | 0.51 |
| 46 | Rice bran | 4-03-928 | 91 | 1,630 | 1,540 | 12.9 | 13.0 | 11.4 | 0.07 | 1.50 | 1.73 | 0.07 | 0.019 | 0.95 |
| 47 | Rice, broken | 4-03-932 | 89 | 2,990 | 2,510 | 8.7 | – | 9.8 | 0.08 | 0.39 | 0 | 0.08 | – | 0.11 |
| 48 | Rice, polishing | 4-03-943 | 90 | 3,090 | 2,090 | 12.2 | 11.0 | 4.1 | 0.05 | 1.31 | 1.06 | 0.11 | 0.016 | 0.65 |
| 49 | Safflower meal, solvent | 5-04-110 | 91 | 1,600 | 1,160 | 42.5 | 1.3 | 15.0 | 0.4 | 1.3 | 0.67 | 0.03 | 0.048 | 0.26 |
| 50 | Sesame meal, expeller | 5-04-220 | 93 | 2,210 | 1,720 | 43.8 | 8.6 | 9.7 | 1.99 | 1.37 | 1.20 | 0.06 | – | 0.77 |
| 51 | Skim milk, dried | 5-01-175 | 93 | 2,520 | 1,670 | 33.5 | 0.9 | 0.2 | 1.28 | 1.02 | 1.59 | 0.50 | 0.001 | 0.11 |
| 52 | Sorghum, grain (milo) | 4-04-444 | 89 | 3,370 | 2,400 | 8.9 | 2.8 | 2.3 | 0.03 | 0.28 | 0.32 | 0.09 | 0.004 | 0.13 |

From: Nutrient Requirements of Poultry, Seventh revised edition, 1977. The National Research Council, National Academy of Sciences Press.

## TABLE C-2

| Manganese (mg/kg) | Sodium (%) | Sulfur (%) | Copper (mg/kg) | Selenium (mg/kg) | Zinc (mg/kg) | Biotin (mg/kg) | Choline (mg/kg) | Folacin (mg/kg) | Niacin (mg/kg) | Pantothenic acid (mg/kg) | Pyridoxine (mg/kg) | Riboflavin (mg/kg) | Thiamine (mg/kg) | Vitamin $B_{12}$ (mg/kg) | Vitamin E (mg/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30.0 | 0.12 | 0.17 | 10.2 | 0.338 | 24 | 0.30 | 1,401 | 4.2 | 38 | 25 | 6.5 | 13.6 | 3.4 | 0.004 | 125 |
| 42.3 | 0.13 | 0.43 | 11.2 | 0.288 | 25 | 0.33 | 1,419 | 3.3 | 40 | 34 | 8.0 | 15.2 | 5.8 | 0.004 | 144 |
| – | 0.04 | 0.15 | 10.2 | 0.10 | 17 | 0.15 | 990 | 0.7 | 55 | 8 | 3.0 | 1.8 | 1.9 | – | 20 |
| 16.3 | 0.02 | 0.15 | 7.7 | 0.102 | 15 | 0.15 | 1,034 | 0.5 | 48 | 7 | – | 1.6 | 4.0 | – | 20 |
| 5.1 | 0.32 | 0.32 | 9.7 | 0.01 | – | 0.08 | 695 | 0.1 | 29 | 3 | – | 2.6 | 0.4 | 44.0 | – |
| 6.4 | 0.33 | 0.32 | 8.1 | – | 306 | 0.20 | 280 | 0.4 | 13 | 5 | 4.4 | 1.3 | 0.5 | 44.0 | – |
| 40.9 | 0.07 | 0.32 | 8.3 | – | 425 | – | 693 | – | 30 | 3 | – | 5.9 | 0.4 | 0.069 | – |
| 37.8 | 0.15 | 0.31 | 21.1 | 0.70 | 98 | 0.96 | 1,723 | 7.1 | 29 | 8 | 0.65 | 1.4 | 0.5 | – | 25 |
| 33.8 | 0.05 | – | 9.5 | – | 9 | – | 440 | – | 19 | 12 | – | 5.5 | 4.0 | – | – |
| 3.4 | 0.73 | 0.03 | – | – | – | 0.29 | 1,707 | 0.4 | 9 | 34 | 2.43 | 31.3 | 3.3 | 0.037 | 6 |
| 4.2 | – | – | 4.0 | – | – | 0.05 | 205 | 0.5 | 1 | 3 | 0.4 | 1.5 | 0.5 | – | – |
| 5.0 | 0.02 | 0.08 | 3.2 | 0.03 | 10 | 0.06 | 620 | 0.4 | 24 | 4 | 7.0 | 1.0 | 3.5 | – | 22 |
| 7.7 | 0.01 | 0.18 | 6.7 | 0.073 | 9 | 0.05 | 393 | 0.3 | 17 | 4 | 5.0 | 0.9 | – | – | 19 |
| 23.8 | 0.95 | 0.22 | 47.9 | 0.1 | 7 | 0.33 | 1,518 | 0.3 | 66 | 17 | 15.0 | 2.4 | 2.0 | – | 15 |
| 8.9 | 0.07 | 0.40 | 28.3 | 1.0 | 20 | 0.18 | 926 | 0.4 | 50 | 10 | 7.9 | 1.7 | 0.2 | – | 20 |
| 4.4 | 0.02 | 0.43 | 26.4 | 1.0 | 33 | 0.15 | 330 | 0.2 | 55 | 3 | 6.2 | 2.2 | 0.3 | – | 24 |
| 22.9 | 0.04 | 0.40 | 18.6 | 0.06 | – | 0.60 | 2,753 | 1.0 | 38 | 10 | 5.3 | 5.1 | 6.4 | – | 39 |
| 20.0 | 0.04 | – | 17.8 | – | 62 | 0.55 | 2,933 | 2.7 | 40 | 7 | 3.0 | 4.0 | 3.3 | – | – |
| 23.9 | 0.48 | 0.30 | 56.6 | 0.390 | 80 | 0.78 | 2,637 | 0.9 | 71 | 11 | 2.20 | 8.6 | 2.9 | – | 40 |
| 73.7 | 0.26 | 0.37 | 82.7 | 0.332 | 85 | 1.10 | 4,842 | 1.1 | 116 | 21 | 10 | 17.0 | 6.9 | – | 55 |
| 21.0 | 0.71 | – | – | – | 54 | 0.44 | 891 | 0.2 | 27 | 10 | – | 2.1 | 0.1 | 0.078 | – |
| 9.5 | 0.88 | 0.54 | 9.3 | 1.363 | 103 | 0.23 | 4,408 | 0.2 | 100 | 15 | 4.0 | 7.1 | 0.1 | 0.352 | 4 |
| 4.7 | 0.61 | 0.69 | 5.9 | 1.930 | 132 | 0.31 | 5,306 | 0.8 | 93 | 17 | 4.0 | 9.9 | 0.1 | 0.403 | 22 |
| 33.0 | 0.41 | 0.45 | 10.8 | 2.103 | 147 | 0.20 | 3,056 | 0.6 | 55 | 9 | 4.0 | 4.9 | 0.5 | 0.104 | 7 |
| 23.0 | 0.18 | 0.30 | 20.0 | 1.756 | – | 0.10 | 3,135 | – | 70 | 10 | – | 6.0 | 0.3 | 0.236 | – |
| 9.8 | 1.1 | 0.50 | 6.4 | 1.714 | 64 | 0.12 | 5,180 | 0.3 | 49 | 10 | 4.1 | 6.0 | 2.1 | 0.081 | 8 |
| 14.4 | 2.62 | 0.12 | 44.9 | 2.0 | 38 | 0.18 | 3,519 | – | 169 | 35 | 12.2 | 14.6 | 5.5 | 0.347 | – |
| 50.1 | 0.37 | 0.40 | – | – | 76 | 0.26 | 5,507 | – | 271 | 55 | – | 7.7 | – | 0.401 | 6 |
| – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| 14.5 | 0.10 | 0.03 | 13.3 | 0.10 | 3.0 | 0.13 | 971 | 0.3 | 46 | 8 | 11.0 | 2.2 | 7.9 | – | – |
| 247.5 | 0.06 | 0.04 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| 8.8 | – | – | 88.9 | – | – | 0.02 | 11,311 | 5.5 | 204 | 29 | – | 46.3 | 0.2 | 0.498 | – |
| 14.2 | 0.72 | 0.50 | 1.5 | 0.25 | 93 | 0.64 | 1,996 | 0.32 | 46 | 4.1 | 12.8 | 4.4 | 0.8 | 0.070 | 1.0 |
| 9.7 | 1.15 | 0.49 | 9.8 | 0.42 | 103 | 0.17 | 2,077 | 0.3 | 57 | 5 | 3.0 | 5.5 | 0.2 | 0.068 | 1.0 |
| 4.7 | 0.93 | 0.48 | 17.7 | – | 14 | – | 829 | – | 42 | 4.0 | – | 2.1 | – | – | 5.1 |
| 42.0 | 0.16 | 0.35 | 0.6 | – | 30 | – | 891 | 0.1 | 43 | 4 | – | 2.4 | – | – | 5.4 |
| 43.2 | 0.08 | 0.21 | 8.3 | 0.30 | 17 | 0.11 | 946 | 0.3 | 12 |  | 1.0 | 1.1 | 6.0 | – | 20.0 |
| 38.0 | – | – | – | 0.07 | – | 0.11 | 959 | 0.3 | 14 | 13 | 1.3 | 1.1 | – | – | 20.0 |
| 13.6 | 0.04 | – | 3.1 | – | 0.1 | – | 264 | 0.96 | 7 | 3 | – | 1.5 | 0.6 | – | – |
| 127.5 | 0.20 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| – | 0.04 | – | – | – | 30 | 0.18 | 642 | 0.4 | 34 | 10 | 1.0 | 2.3 | 7.5 | – | – |
| 25.1 | 0.07 | 0.29 | – | 0.29 | 20 | 0.76 | 1,655 | 0.4 | 166 | 47 | 10.0 | 5.2 | 7.1 | – | 2.9 |
| 28.9 | 0.07 | – | – | – | 20 | 0.39 | 2,396 | 0.4 | 170 | 53 | 10.0 | 11.0 | – | – | 3.0 |
| 11.0 | 0.40 | 0.51 | 14.0 | 0.75 | 120 | 0.30 | 5,952 | 1.0 | 40 | 12.3 | – | 11.0 | 1.0 | 0.31 | 2.0 |
| 61.0 | 0.5 | – | 7.0 | 0.98 | 44 | – | 6,464 | – | 153 | 9 | 7.0 | 3.7 | 1.7 | – | 19.1 |
| 324.5 | 0.07 | 0.18 | 13.0 | – | 30 | 0.42 | 1,135 | – | 293 | 23 | 14.0 | 2.5 | 22.5 | – | 59.8 |
| 18.0 | 0.07 | 0.06 | – | – | 17 | 0.08 | 800 | 0.2 | 46 | 8 | – | 0.7 | – | – | 14.5 |
| – | 0.10 | 0.17 | – | – | 26 | 0.61 | 1,237 | 0.2 | 520 | 47 | – | 1.8 | 19.8 | – | 90.0 |
| 15.6 | 0.10 | 0.06 | 8.5 | – | 33 | 1.40 | 2,067 | 0.4 | 22 | 40 | – | 2.4 | – | – | 0.7 |
| 47.9 | 0.04 | 0.43 | – | – | 100 | 0.34 | 1,530 | – | 30 | 6 | 12.5 | 3.6 | 2.8 | – | – |
| 2.0 | 0.44 | 0.31 | 11.5 | 0.12 | 40 | 0.33 | 1,393 | 0.5 | 11 | 37 | 3.9 | 19.0 | 3.5 | 0.037 | 9.1 |
| 13.6 | 0.04 | 0.16 | 19.0 | – | 14 | 0.18 | 450 | 0.2 | 41 | 12 | 3.2 | 1.1 | 4.0 | – | 12.0 |

From: *Nutrient Requirements of Poultry*, Seventh revised edition, 1977. The National Research Council, National Academy of Sciences Press.

## TABLE C-3

| Line No. | Feedstuff | International Feed No. | Dry Matter (%) | Energy (kcal/kg) |  | Protein (%) | Ether Extract (%) | Crude Fiber (%) | Calcium (%) | Phosphorus (%) | Potassium (%) | Chlorine (%) | Iron (%) | Magnesium (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  | $ME_n$ | Pro |  |  |  |  |  |  |  |  |  |
| 53 | Soybeans, heat processed | 5-04-597 | 90 | 3,300 | 2,170 | 37.0 | 18.0 | 5.5 | 0.25 | 0.58 | 1.61 | 0.03 | 0.008 | 0.28 |
| 54 | Soybean meal, dehulled | 5-04-612 | 90 | 2,440 | 1,730 | 48.5 | 1.0 | 3.9 | 0.27 | 0.62 | 2.02 | 0.05 | – | – |
| 55 | Soybean meal, expeller | 5-04-600 | 90 | 2,430 | 1,720 | 42.6 | 4.0 | 6.2 | 0.27 | 0.61 | 1.83 | 0.07 | 0.014 | 0.26 |
| 56 | Soybean meal, solvent | 5-04-604 | 89 | 2,230 | 1,570 | 44.0 | 0.8 | 7.3 | 0.29 | 0.65 | 2.00 | 0.05 | 0.012 | 0.27 |
| 57 | Soybean mill feed | 5-04-594 | 89 | 720 | 440 | 13.3 | 1.6 | 33.0 | 0.37 | 0.19 | 1.50 | – | – | 0.12 |
| 58 | Soybean protein, isolated[b] | 5-08-038 | 93 | 3,500 | 2,300 | 84.1 | 0.4 | 0.2 | 0.02 | 0.8 | 0.18 | 0.02 | 0.013 | 0.013 |
| 59 | Sunflower meal, solvent dehulled | 5-04-739 | 93 | 2,320 | 1,430 | 45.4 | 2.9 | 12.2 | 0.37 | 1.0 | 1.00 | 0.10 | 0.003 | 0.75 |
| 60 | Wheat bran | 4-05-190 | 90 | 1,300 | 1,050 | 15.7 | 3.0 | 11.0 | 0.14 | 1.15 | 1.19 | 0.06 | 0.017 | 0.52 |
| 61 | Wheat, hard | 4-05-268 | 87 | 2,800 | 2,250 | 14.1 | 1.9 | 2.4 | 0.05 | 0.37 | 0.45 | 0.05 | 0.005 | 0.17 |
| 62 | Wheat middlings | 4-05-205 | 88 | 1,800 | 1,130 | 16.0 | 3.0 | 7.5 | 0.12 | 0.90 | 0.99 | 0.03 | 0.004 | 0.16 |
| 63 | Wheat, soft | 4-05-337 | 89 | 3,120 | 1,980 | 10.2 | 1.8 | 2.4 | 0.05 | 0.31 | 0.40 | 0.08 | 0.004 | 0.10 |
| 64 | Whey, dried | 4-01-182 | 93 | 1,900 | 1,540 | 12.0 | 0.8 | 0.2 | 0.97 | 0.76 | 1.05 | 0.07 | 0.013 | 0.13 |
| 65 | Whey, low lactose | 4-01-186 | 91 | 2,090 | 1,580 | 15.5 | 1.0 | 0.3 | 1.95 | 0.98 | 3.0 | 2.10 | – | 0.25 |
| 66 | Yeast, brewer's, dried | 7-05-527 | 93 | 1,990 | 1,260 | 44.4 | 1.0 | 2.7 | 0.12 | 1.40 | 1.70 | 0.12 | 0.012 | 0.23 |
| 67 | Yeast, torula, dried | 7-05-534 | 93 | 2,160 | 1,540 | 47.2 | 2.5 | 2.4 | 0.58 | 1.67 | 1.88 | 0.02 | 0.009 | 0.13 |

[a] As-fed basis

[b] Soybean protein concentrate (AAFCO).

From: Nutrient Requirements of Poultry, Seventh revised edition, 1977. The National Research Council, National Academy of Sciences Press.

## TABLE C-4

| Line No. | Manganese (mg/kg) | Sodium (%) | Sulfur (%) | Copper (mg/kg) | Selenium (mg/kg) | Zinc (mg/kg) | Biotin (mg/kg) | Choline (mg/kg) | Folacin (mg/kg) | Niacin (mg/kg) | Pantothenic acid (mg/kg) | Pyridoxine (mg/kg) | Riboflavin (mg/kg) | Thiamine (mg/kg) | Vitamin $B_{12}$ (mg/kg) | Vitamin E (mg/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 53 | 29.8 | 0.12 | 0.22 | 15.8 | 0.11 | 16 | 0.27 | 2,860 | 4.2 | 22 | 11 | 10.8 | 2.6 | 11.0 | – | 40.0 |
| 54 | 43.0 | 0.25 | – | 15.0 | 0.10 | 46 | 0.32 | 2,731 | 3.6 | 22 | 15 | 5.0 | 2.9 | 3.2 | – | 3.3 |
| 55 | 30.7 | 0.27 | 0.33 | 24.3 | 0.10 | 60 | 0.33 | 2,703 | 4.4 | 32 | 14 | – | 3.7 | 3.2 | – | 6.1 |
| 56 | 29.3 | 0.26 | 0.43 | 21.5 | 0.10 | 27 | 0.32 | 2,794 | 1.3 | 29 | 16 | – | 2.9 | 4.5 | – | 2.1 |
| 57 | 28.5 | – | 0.06 | – | – | – | – | 640 | – | 24 | 13 | – | 3.5 | – | – | – |
| 58 | 1.0 | 0.07 | 0.71 | 7.0 | 0.1 | 23 | 0.3 | 2 | 2.5 | 6 | 4.2 | 5.4 | 1.2 | 0.2 | – | – |
| 59 | 22.9 | 2.0 | – | 3.5 | – | – | 1.46 | 2,894 | – | 220 | 24 | 16.0 | 4.7 | – | – | 11.0 |
| 60 | 113.2 | 0.05 | 0.22 | 14.1 | 0.85 | 133 | 0.48 | 1,880 | 1.2 | 186 | 31 | 7.0 | 4.6 | 8.0 | – | 13.5 |
| 61 | 31.8 | 0.04 | 0.12 | 5.8 | 0.2 | 31 | 0.11 | 1,090 | 0.35 | 48 | 9.9 | 3.4 | 1.4 | 4.5 | – | 12.6 |
| 62 | 118.0 | 0.12 | 0.26 | 18.1 | 0.8 | 150 | 0.37 | 1,439 | 0.8 | 98 | 13 | 9.0 | 2.2 | 16.5 | – | 40.5 |
| 63 | 23.8 | 0.04 | 0.12 | 6.9 | 0.06 | 28 | 0.11 | 1,002 | 0.4 | 57 | 11 | 4.0 | 1.2 | 4.3 | – | 13.2 |
| 64 | 6.1 | 0.48 | 1.04 | 46.0 | 0.08 | 3 | 0.34 | 1,369 | 0.8 | 10 | 44 | 4.0 | 27.1 | 4.1 | 0.023 | 0.2 |
| 65 | – | 1.50 | – | – | 0.10 | – | 0.64 | 4,392 | 1.4 | 18.6 | 69 | 3.96 | 45.8 | 5.7 | 0.023 | – |
| 66 | 5.2 | 0.07 | 0.38 | 32.8 | 1.0 | 39 | 1.05 | 3,984 | 9.9 | 448 | 109 | 42.8 | 37.0 | 91.8 | – | – |
| 67 | 12.8 | 0.01 | 0.34 | 13.5 | 1.0 | 99 | 1.39 | 2,881 | 22.4 | 500 | 73 | – | 47.7 | 6.2 | – | – |

From: *Nutrient Requirements of Poultry*, Seventh revised edition, 1977. The National Research Council, National Academy of Sciences Press.

TABLE D

## .—Common Protein Sources Used in Poultry Feeding

| *Ingredients* | *Protein usual %* | *Metabolizable energy* | | *Limiting amino acids* | *Comments* |
|---|---|---|---|---|---|
| | | *kcal/lb* | *kcal/kg* | | |
| Meat and bone meal | 50 | 900 | 1980 | Methionine and cystine | Good source of calcium and phosphorus. Protein quality is variable |
| Poultry by-product meal | 58 | 1325 | 2910 | None | Excellent protein if properly prepared |
| Fish meal | 60–70 | 1200–1450 | 2640–3190 | None | Good source of protein of variable quality. Contains Ca and P. Use limited to about 10% of diet to avoid fishy flavors |
| Hydrolyzed feather meal | 84 | 1050 | 2310 | Methionine, lysine, histidine, tryptophan | Poor quality protein. Limited use in poultry rations |
| Blood meal | 80 | 1300 | 2850 | Isoleucine | Often used as source of supplemental lysine |
| Cottonseed meal | 41 | 830 | 1820 | Lysine, methionine | Contains gossypol. Limited use in layer rations |
| Soybean meal, 44% protein | 45 | 1020 | 2240 | Methionine | Soybean meals must be properly heat-treated to destroy inhibitory factors |
| Soybean meal, dehulled | 49 | 1150 | 2530 | Methionine | Soybean meals must be properly heat-treated to destroy inhibitory factors. This dehulled meal most commonly used in poultry rations |
| Peanut meal | 42 | 1000 | 2200 | Methionine and lysine | Should be checked for aflatoxin contamination, particularly when produced in semitropical humid areas |
| Corn gluten meal | 60 | 1750 | 3850 | Lysine, tryptophan | Used extensively to supply xanthophyll pigments to broiler finishing rations |
| Sesame meal | 48 | 1180 | 2600 | Lysine | Good plant source of methionine |
| Sunflower meal | 43 | 800 | 1760 | Lysine and methionine | Variable depending on maturity of seed at harvest |
| Safflower meal, decorticated | 42 | 770 | 1690 | Lysine and methionine | Must have hulls removed during processing |
| Rapeseed meal | 35 | 855 | 1880 | Lysine | Some varieties possess cyanogenic glucosides and goitrogenic compounds that limit levels that can be used |
| Coconut meal | 21 | 700 | 1540 | Lysine and methionine | In tropical areas often mold contaminated |

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# SAMPLE RATION

## SAMPLE RATION

| | o/o Ration | Kcal/kg ME | o/o Crude Protein | o/c Crude Fiber | o/o FAT | o/o Lysine | o/o CA | olo P (Available) |
|---|---|---|---|---|---|---|---|---|
| Fishmeal Anchovetta | 10 | 283 | 6.5 | .1 | .4 | .52 | .4 | .26 |
| Corn Dent #2 Yellow | 48 | 1618 | 4.1 | .1 | 1.9 | .10 | 010 | .05 |
| Rice Bran | 20 | 326 | 2.4 | 2.4 | 2.6 | .15 | 024 | .04 |
| Meat & Bone Meal 50% | 7 | 139 | 3.5 | .14 | .7 | .18 | .74 | .36 |
| Cassava Flour | 5 | 186 | .09 | .09 | | .07 | -- | .006 |
| Soybean Bean Meal Dehulled | 10 | 253 | 4.9 | .3 | .08 | .32 | 026 | .024 |
| Total | 100 | 2805 | 21.5 | 3.9 | 5.7 | 1.27 | 1.2 | .74 |
| Requirement for Geese 0-6 Weeks | | 2900 | 22 | MAX 5 | MAX 5 | .9 | .8 | .6 |

Calorie Protein Ratio

$$\frac{2805}{215} = 130$$

Calorie Protein Ratio

$$\frac{2900}{22} = 132$$

The sample ration is for Geese (0-6 weeks) #11, the nutrient requirements are from TABLE A. This is a high production ration, satifying the nutrient requirements for:

1. Metabolizable Energy (ME)
2. Crude Protein (CP)
3. Crude Fiber (CF)
4. Fat (F)
5. Lysine
6. Calcium (Ca)
7. Available Phosphorus (Pavail)

All of these, except ME, are expressed as a percentage of the ration. Six ingredients have been used to satify the requirements by mixing the ingredients in different proportions. ME is an energy value expressed in kilocalories per kilogram (kcal/kg) or kilocalories per pound (kcal/lb). Requirement for FAT/FIBER is not listed, but the maximum should be 5-7%. Although volunteers may not be working in high production projects, it is valuable for the trainees to practice on high production ration because:

1. The trainees will learn about more feed ingredients (low production might involve only two ingredients).

2. More computation and problem solving experience will be performed by the trainees.

3. The trainees may be involved in moderate-high production poultry projects.

Materials and Resources Needed:

1. Nutrient requirements for various poultry. TABLE A.

2. List of feed ingredients with their nutrient values. TABLE C 1-4.

3. List of ingredients with their maximum limits of use. (Practical Poultry Raising (P.P.R.) p. 139, and Appendix E. p. 205-206).

4. Caculator and/or good basic math skills.

Procedure

In this exercise we are satisfying some of the critical nutrient requirements. If you want to be more precise, you can include other nutrients, such as methionine, potassium, etc. We will deal with only 7 nutrients in this exercise. Basically, we are trying to select ingredients that will provide us with enough CP, ME, F, Ca, P, and Lysine. To satisfy our requirements, we have to select ingredients that will satisfy our protein and Lysine Requirement (protein concentrates) and Energy Requirements (Energy Feeds). Hopefully, these will also help to satisfy mineral requirements.

### STEP ONE:

CHECK YOUR LIST OF INGREDIENTS FOR MINIMUM USE. This is important in order to make sure the ingredient does not add too much Fat and/or Fiber which would affect digestibility (see p. 139 in P.P.R.) or cause distress to the chicken. For example, fishmeal was added to the sample ration, but only 10%. More than 15% causes meat and/or eggs to taste like fish.

### STEP TWO:

CHECK NUTRITION VALUES OF THE INGREDIENTS. Look at the composition table of Poultry Feed Stuff TABLE C, 1 & 2 and Amino Acids, TABLE C, 3 & 4. Fishmeal (anchovetta) values are:

| CP | ME | FAT | C.F | Ca | P (avail) | Lysine |
|---|---|---|---|---|---|---|
| 65 | 2830 | 4 | 1 | 4 | 2.6 | 5.2 |

### STEP THREE:

If we want to add 10% fishmeal we would determine 10% of 65 (value for C.P.) and we would get 6.5 (.1 x 65 = 6.5). This means that if 10% of the ration is fishmeal, 6.5% protein will come from fish. A total of 22% is needed so approximately 1/3 of our requirement is already met. Check the value for Crude Protein in the sample ration (page two). Remember 6.5 is a percentage. If you had one pound of fishmeal, .65 pound would be crude protein. If you feed your chickens a ration consisting only of fishmeal, that ration would have a total of 65% crude protein. But since fishmeal is only 10% of ration, then, 6.5% protein comes from fishmeal.

ME is expressed in kilocalorie per kg. Fishmeal, according to TABLE C-1, has 2830 kilocalorie/kilogram. The requirement stated in TABLE A is 2900 kilocalories/kilogram. If the finished ration consisted of only fishmeal, the ME value would be 2830 kilo/kg. since we are using only 10% = the value is only 283 (.1 x 2830 = 283). (Check sample ration). Since our requirement is 2900 we have approximately 10% of our energy requirements satisfied. Multiplying .1 times the values for Crude Fiber, Fat, Ca, Phosphorus, Lysine will give you amount of nutrients supplied by Fishmeal.

### STEP FOUR:

This procedure is followed with the other ingredients and once all the values are computed and totaled one can compare how close one has come to the requirement. Check sample ration eg.: Requirement for Geese (0-6 weeks) ME is 2900 kilocalories/kg. Total for sample ration is 2805 kilocalorie/kg.

### STEP FIVE:

In order to determine if this is close enough, you must check your Calorie to PROTEIN RATIO (P. 141 P.P.R.).

If you check the values for fishmeal, you will notice that 10% has satisfied approximately 1/3 of the crude protein requirement, more than half of the lysine and calcium requirement, and approximately 1/3 of the available phosphorus. In regard to ME, it carries its own, 10% of fishmeal satisfies 10% of the ration. PROTEIN SOURCES. Fishmeal is therefore an ideal ration ingredient especially as a protein concentrate and mineral supplement. It supplies the most limiting Amino Acid, Lysine. This is why you usually need one animal protein source in your ration in order to satisfy the lysine requirement.

TABLE D

Common Protein Sources Used lists possible other ingredients that can be used as protein concentrates. The limitation on these ingredients is usually cost, and/or whether protein should be fed to people rather than animals. Notice that these ingredients are usually byproducts of oil or syrup and starch extraction. Meat and bone meal, which is used in the ration, is a good source for Ca and P, but not as good a source of protein as fishmeal. (See values in sample ration p. 254).

## ENERGY SOURCE

Corn is a good example of a high energy feed. It supplies about 58% of the energy in the sample ration. Check TABLE B for Characteristics of Grains Used in Poultry Feeding. Grains in general are low in protein and deficient in the amino acids lysine and tryptophan. They are low in minerals, particularly sodium, calcium, and available phosphorus. Yellow corn is also a good source of xanthophyll pigments, that yellow coloration of shanks and skin of broilers and yolks of eggs. In addition some of these pigments can be converted to vitamin A by intestinal mucosa of animals. Corn contains about 4 percent fat which is 50 percent linoleic acid, making it a good source of this essential fatty acid in poultry ration.

## FIBER

Fiber is usually limited to 5-7% of the ration because the amount will interfere with the amount of feed the chicken can consume. (See p. 136 in P.P.R.). Fiber is sometimes used to control cannibalism. (See P.P.R. p. 77-78). Adding oats or another fiber grain, it is believed, will reduce the desire for chickens to peck at one another.

## FAT

Fat is limited to 3-5% of ration. If pellets are used it can go as high as 8%. The main limitations in using fats are usually:

1. Cost.
2. Physical nature of the ration containing fat; rations very high in fat tend to cake and do not flow very easily.
3. Digestibility (especially animal fats).
4. Fats containing unsaturated fatty acids may not be stable and may undergo oxidative rancidity which can result in the destruction of vitamins A, D and E.

MINERAL SUPPLEMENT CALCIUM AND PHOSPHORUS. The mineral elements most likely to be deficient in rations for poultry are calcium, phosphorus, sodium chlorine, maganese, and zinc.

Calcium: Sources of Ca and Phosphorus are listed in TABLE B, Calcium and Phosphorus Sources Available For Poultry Feeding.

The most common sources of Ca in a poultry ration are ground limestone and marine shells. Both are basically calcium carbonate. Limestone intended for animal feeding should be used instead of agricultural lime. If you check Nutrient Requirements for Poultry in TABLE A, you will notice that the Ca requirement is much higher for layers and breeders. The demand is high because of the number of eggs laid. Each egg contains about 2 grams of calcium.

The animal usually does not effectively utilize Ca, so a high amount is required to compensate for this inefficiency of utilization. Other reasons that a high amount of Ca is required are:

1. In the tropics or extremely hot weather, thinner egg shells are produced due to decrease in feed consumption, and increase of the respiration rate (panting) to keep cool.

2. Near the end of the laying cycle, egg shells are normally thinner.

3. Older birds will lay eggs with thinner shells.

Under the above conditions, Ca can be increased up to 4-4.5% of the ration. Forty percent of the Ca requirement can be supplied by allowing birds access to a calcium-source hopper or feeding. (Read page 142 in P.P.R.).

CALCIUM/PHOSPHORUS RELATIONSHIP

Calcium and phosphorus are closely related in the formation of bone. In a growing chicken the major portion of the calcium in the diet is used for bone formation while in a mature animal the major portion is used for egg shells.

Not only are minimal level calcium and phosphorus required in the diet, but also at optimum ratio levels. Too much calcium or phosphorus can interfere with the formation of bone or egg shells. The minimal available phosphorus requirement is approximately 0.5%.

The calcium/phosphorus ratio needed for normal results in growing chicks varies between 1.0:1 and 2.2:1. A ratio of 2.5:1 appears border line. A ratio of 3.3 to 1 can be disastrous, causing rickets and other leg abnormalities. Ratios can excede this amount in laying hens because of the amount of calcium going into egg shell formation.

## PHOSPHORUS AVAILABILITY

Considerable amounts of phosphorus are found in plants in the form of phytin (bound) phosphorus. In general, phytin phosphorus is unavailable to all simple-stomach animals because of the lack of the enzyme, phytase, in the gastrointestinal tract. Studies have also shown that the amount available varies according to the species and the level of vitamin D in the ration.

While some studies state that organic (present in plants) phosphorus is poorly utilized by growing birds, but satisfactory for adult birds, others show that laying hens fed rations adequate in vitamin D utilize it only about half as effectively as inorganic phosphorus, and growing birds can only utilize about 30% of the organic plant phosphorus. It is important therefore, when determining a ration, that the values used for phosphorus from a particular ingredient be based on whether that ingredient is from a plant source or not, and whether the animal is growing or mature.

This section has not emphasized the value of a feedstuff based on cost. (Check P.P.R., page 143). This is an important consideration because sometimes it might be more economical to feed a less nutritious ingredient if the cost is less than a more nutritious ingredient, provided the animal can compensate by eating more. For example, wheat may have a lower energy value than corn, so a chicken would have to eat more to satify its energy requirement. It is also cheaper, so it might be better to use wheat in the ration, unless the chicken would have to eat so much more as to make it more expensive to use than corn. It will not be feasible if the feed ingredient has so little energy value or so much fiber that it would be physically impossible for the chicken to consume and hold that much food in its gut (e.g. it may be difficult to substitute oats completely for corn because oats are a high fibrous bulky food, even though oats may be a less expensive feed ingredient).

## POSSIBLE POULTRY FEEDSTUFF IN THE TROPICS

### Coconut oil meal (copra meal)

1. Plentiful source of protein in tropical countries.
2. 40% can be used in both broiler and layer diets provided the diet contains good sources of methionine and lysine (coconut oil meal is deficient in these essential amino acids). Good source of these amino acids is Fishmeal.
3. Possible problem with storage and processing in tropics because of severe mold growth which could be toxic to chickens. Prevention: Spray fresh copra with alcoholic solution of sodium propionate.
4. Both coconut oil meal and Palm Kernel oil meal may represent potential poultry feed stuff for certain areas.

## Sunflower Meal, Sesame Meal, and Safflower Meal

1. In parts of the world, oilseed residues are important sources of protein.
2. All are deficient in lysine, high in fiber and low in ME.
3. Sesame is a good source of methinonine.

## Cassava (Yuca/Monioc)

1. Possible source of carbohydrate production in the tropics.
2. Fiber also called cassava root. Meal is called tapioca.
3. Staple food in West Africa, but must be processed very carefully, because the unpeeled roots contain a very poisonous compound, prussic acid.
4. If fed to poultry, the meal must be mixed with water or molasses.
5. Limit to 10% in broiler rations. Limit to 20% in layer rations. Up to 50% in chick rations can replace corn if supplemented with methionine (.15%), when the diet is a corn, soybean mixture.

NOTE: Cassava is very low in protein, including methionine, so is soybean, for protein source, while corn is not.

6. Other tubers such as yam, plantain, sweet potato, cocoyam, have been tested as an energy source in high production rations and only sweet potatoes improved the growth rate of chicks.

## Dried Sugarcane Juice and Unrefined Sugar

1. Dehydrated byproduct of sugar refining process which contains approximately 89% sugar, 3% crude protein, 3% ash, traces of fat and about 5% moisture.
2. 20-25% can be used in layer and broiler diets, if diet is balanced in terms of protein, amino acids, minerals and vitamins.
3. If sugar is a superabundant crop, this may be a possible carbohydrate source.

## Rice Polishing and Rice Bran

1. Byproduct of winnowing the chaff from the grain.
2. Contains approximately 13% protein and 13% fat.

3. Possible feedstuff, if free of adulteration with rich hulls, and high rice oil level can be stabilized by antioxidant so energy value will not be lost through oxidative rancidity.

Ipil-Ipil Leaf Meal

1. Produced from the leaves of the leucaena, a leguminous tree found in tropical countries.

2. Meal contains over 24% protein, 3.25% fat and about 14% fiber.

3. Limited to 3-4% of the diet because it contains a toxic alkaloid known as mimosine. More in the diet will reduce growth rate in broilers and reduce egg production.

Fermentation Byproducts, yeast, and distiller dried solubles are products obtained from breweries and distilleries which are found all over the world.

1. Distillers' dried solubles are obtained by drying the residue from the yeast fermentation of whatever grain (corn, rye, rice, molassess, etc.) after the removal of alcohol by distillation.

2. The main use in poultry feeding is dried yeast (brewers, grain distillers' dried yeast, molasses distiller dried yeast) which are byproducts of the brewery or distilling industry.

3. These byproducts are good sources of protein and B complex vitamins. If dried properly, distillers' dried grains are still a potential feed source in Third world countries because they are still in the process of utilizing these byproducts.

Other feedstuffs used for poultry in other parts of the world are grar meal, carob meal, coffee oil meal, and various grass, bean, and pea meals. Torula yeast, a byproduct of the paper pulp industry and primary fementation of molasses is also a possible vitamin supplement.

## FINAL NOTE

When a volunteer is considering possible feedstuffs he/she must remember to also consider whether a ration will be competing with feeds that people eat directly.

If an energy feed is used to produce a protein food, and that protein food is too expensive for those people who depend on that energy food for their diet to buy, then producing a higher food value may have dubious, possibly harmful, results. Besides making money, small scale animal projects should try to increase the level of nutrition for those who need it the most.

## Poultry Disease

The poultry disease section of the outline is basically a supplement to Chapter 7, Keeping Chickens Healthy in Practical Poultry Raising and Salsbury Manual of Poultry Disease. In case the Salsbury Manual is not available, a portion of the manual is included in this section which covers those diseases mentioned in Practical Poultry Raising.

It is believed that the use of these two publication will give the trainee a solid understanding of poultry disease. Supplementation in the guidelines includes copies of vaccination directions, basic poultry disease diagnostic guide, insects that attack poultry, and a chicken vaccination outline.

The trainee should remember that no amount of information is going to give him/her the skills and ability to diagnose disease like a veterinarian. Unfortunately, however, volunteers may be the only resource to deal with a disease problem in the area.

In spite of all this, it is still necessary for a trainee to learn proper post mortem/slaughter technique and disease diagnosis. The reasons are:

1. Trainee can learn more about the anatomy and organs of the chickens and how they function.
2. Trainee can become more independent in preparation of his/her own food.
3. Trainee has a more sensitive and clear understanding how food is prepared in other countries.
4. Post mortem procedure can be a credibility technique.

## Credibility Technique

A volunteer visits a farmer who has had one of his chickens die. The volunteer does a post mortem and finds that the chicken died because it had eaten some twine which blocked the passage of food from preventriculum (stomach) to the gizzard. The volunteer also finds roundworms in the intestine. The volunteer and farmer know that the chicken did not die of an infection or contagious disease, so there is no concern for the health of the rest of the flock. But the farmer and volunteer have found out that the chicken, and probably the rest of the flock, has worms. If possible they can now treat this parasite problem. Since the farmer has been shown a possible problem by the volunteer, using a technique (post mortem), the volunteer's qualifications may appear to be more credible to the farmer. The farmer will develop a trusting relationship with the volunteer, and may readily accept other management suggestions and advice. This is an example of a credibility technique, and how learning a particular skill can help a volunteer in his or her job.

## Cross Reference Guide

### Poultry Disease

| Disease | Prac. Poultry Chapter 7 Raising | Dr. Salsbury |
|---|---|---|
| Newcastle | P. 118 | P. A |
| Fowl Pox | P. 119 | P. B |
| Fowl Cholera | P. 120 | P. C |
| Infectious Bronchitis | P. 120 | P. D,E |
| Laryngotracheitis | P. 121 | P. F |
| Marets Disease | P. 121 | P. G |
| Pullorum (salmonella) | P. 122 | P. H |
| Coccidiosis | P. 122-123 | P. I,J,K,L |
| Infectious Coryza | P. 124 | P. M |
| Parasites | P. 125-127 | P. N,O,P,Q |
| Performing A Post Mortem Examination | P. 128-130 | P. R,S |

NOTE: PAGES 346, 347, and 348 HAVE BEEN INTENTIONALLY OMITTED.

# Basic Poultry Disease Diagnostic Guide

This Poultry Diagnostic Guide is a compilation in chart form of basic information relative to diagnosis of disease problems in poultry occurring in the different age groups.

BROODING PERIOD (Day-Old To 4 Weeks Old)

| Clinical Signs | Possible Causes |
|---|---|
| Huddling near heat source | Low brooding temperature. Disease condition - salmonellosis, coccidiosis, NCD, CRD, etc. |
| Diarrhea | High salt content of feed (normal level is 0.37%). If whitish diarrhea with mortality - salmonellosis or bacterial enteritis (coliform infection). If bloody with mortality - coccidiosis. |
| Panting or gasping | High brooding temperature. Poor ventilation, strong ammonia odor. Pullorum disease or respiratory disease - NCD, IB, CRD, aspergillosis and air sacculitis. |
| Sudden heavy mortality | Suffocation - poor ventilation. Food poisoning. Disease conditions such as coccidiosis, acute typhoid, cholera, salmonellosis, and wing rot. Poor stock. |
| Tremors/paralysis | Epideic tumor (AE). Vitamin E deficiency. Mineral deficiencies. NCD (usually following respiratory signs). |
| Drop in feed consumption | Stale or unpalatable feed. High brooding temperature. Disease conditions - CRD, NCD, IB, salmonellosis, etc. |
| Watery eyes/nasal discharge | Strong ammonia odor. Disease problems - infectious bronchitis, IB, and CRD. |
| Conjuctivitis | Strong ammonia odor. NCD. |
| Paleness | Nutritional problem - poor quality feeds or faulty feeding. Coccidiosis. Wing rot. |
| Poor feathering/ poor growth/ lack of uniformity | Faulty nutrition - check feed and feeding system. Subclinical infections. Overcrowding. Poor brooding temperature. Poor stock. |

Layers/Breeders

| Clinical Signs | Possible Cause(s) |
|---|---|
| Paleness | Nutritional problem - poor quality feed or faulty feeding. Chronic coccidiosis. Blood parasitism, avian malaria, aegyptianellosis, or leucocytozoonosis. Crop mycosis. Marek's disease. Lymphoid leukosis. |
| Paralysis | Nutritional deficiency. Cage layer Fatigue. Marek's disease. Mechanical cause. |
| Watery eyes/ nasal discharge | Strong ammonia odor. Disease problems IB, NCD, CRD, and coryza. |
| Gasping, tracheal rales | NCD, IB, CRD, coryza, and laryngo - tracheitis and fowl pox (wet type). |
| Sudden drop in egg production | Nutritional problem - abrupt change in feed. Stress condition - sudden change in weather condition, fright. Vaccination. Sulfa medication. Deworming. Acute disease problems - NCD, cholera, IB. |
| Soft shelled egg | High environmental temperature. Nutritional problem - calcium, phosphorus, vitamins A & D deficiency. Sulfa medication. Disease problems - IB, NCD, fowl cholera, etc. |
| Poor egg production | Nutritional problem - faulty feeding, poor quality feed. Subclinical or chronic infections. Parasitism - external or internal parasites. Poor housing - overcrowding, poor ventilation. Poor stock. |

## Insects that Attack Poultry

### Field Key for the identification of insects injuring poultry

A. Pests that visit the fowls only to secure food, coming and going repeatedly; or live on the fowls at night, hiding away in the daytime, or spend only part of the life cycle on the fowls, being free-living or intermittent parasites during other life stages:

1. Mahogany-brown, broad, very flat or thin, oval, wingless bugs, of all sizes to up 1/5 inch long, live in nests, behind boards, and in cracks of houses during the day time, and crawl out upon fowls at night and suck blood. Bugs have a bad odor. Small black spots of excreta from the bugs often seen on the eggs and about cracks ........................................................Bed bug.

2. A tiny, hard, long-legged, jumping insect, about 1/20 inch long and flattened from side to side; females attach to, or burrow into, the skin about the eyes, comb, wattles, or vent in clusters, often forming dark areas visible from some distance; ulcers, blindness, and death, especially of young chicks, often result. Immature stages are passed in cracks of the henhouse or in the soil. A southern species .............Sticktight or southern chicken flea.

3. Small grayish to dark-red pear-shaped or ovate mites, from 1/40 to 1/20 inch long, with 9 slender legs, remain in cracks under the roost or in nest boxes during the day, except on sitting or laying hens in dark places. At night they swarm over the birds and suck the blood..............................Poultry mite or roost mite.

4. Poultry are attacked by a larger 8-legged oval-bodied brown tick up to 1/3 inch long, which in the adult stage attacks the host only at night, when it sucks blood in quantities, and hides in cracks during the day like the poultry mite. In its younger stages, however, it is a permanent parasite, remaining on the fowl day and night until ready to molt ......Fowl tick, adobe tick, or bluebug.

B. Small wingless, flattened chewing lice that stay on the skin or feathers of the fowls all the time:

1. Ovate yellow lice, less than 1/16 inch long, with a single transverse row of hairs on each abdominal segment, above. Found along the shafts of the feathers of chickens rather than on the skin; when the feathers are parted, they run toward the body along the shaft. Chew at the feathers. Eggs glued to base of feathers. Not on young chicks............Small body louse or shaft louse.

2. Similar lice, from 1/10 to 1/8 inch long, darker yellow and more hairy; the hairs on upper side of abdomen in 2 transverse rows on each segment. Found running rapidly over the skin of chickens, turkeys, and pheasants in less feathered parts; not on the features. The most injurious species on grown chickens. Eggs attached especially to small feathers below the vent.

3. Similar to the head louse but more slender and darker in color. The only species found commonly on the large wing feathers of chickens, where it often lies between the barbules on the underside of the shaft showing no signs of life. Eggs between barbules of large feathers ........................................Wing louse.

4. A small species, only 1/25 inch long, with head curiously expanded and rounded in front; dark red in color, with a white region in middle of abdomen; is common at the base of the large wing feathers of ducks and geese ................................................ Biting louse of ducks and geese, Docophorus icterodes Nitzsch.

C. Minute, almost invisible, 8-legged rounded mites that burrow into the skin beneath scales of legs or at base of feathers and feed and reproduce in the tunnels.

1. Chickens, turkeys, pheasants, and other birds walk painfully or refuse to walk. Legs are encrusted with elevated scales from which a fine white powder and serum exude from the irritated and inflamed skin, and the legs become much swollen. Numerous minute, circular, very short-legged mites less than 1/50 inch long burrow under the scales ..............................Scaly leg mite.

2. A similar but still smaller mite burrows into the skin at the base of the feathers of the rump, back, abdomen, and neck of chickens and pigeons, cutting the feathers to fall or to be pulled out by the bird. If the stumps of such feathers are examined, an abundance of dry scales, crusts, and mites will be found .......... ..............................Depluming mite.

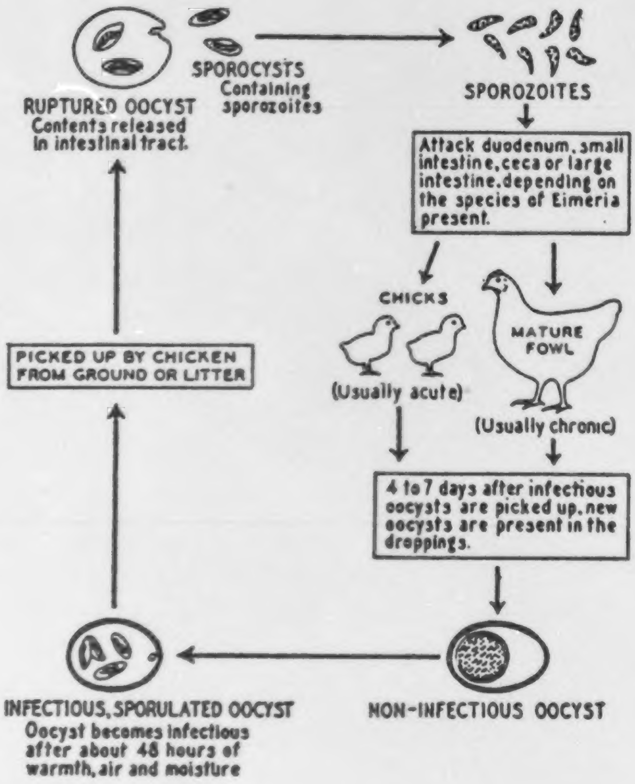
Animal Attacked. Every kind of domestic fowl (and probably every kind of wild bird as well) has from one to several kinds of lice. In general, each species of birds has lice peculiar to it. The exceptions to this will be noted in discussing the different lice. At least a dozen kinds attack chickens and three to five different kinds are found on ducks, pigeons, and turkeys.

Distribution. Wherever fowls are kept.

Life History, Appearance, and Habits. Poultry lice generally breed faster and become more abundant in summer than in cold weather, but all stages can usually be found on the host in winter. All these chewing lice are permanent parasites, spending all life stages, generation after generation on the same bird, and never normally leaving its body, except as they pass from one fowl to another, particularly from old to younger birds. The eggs are cemented fast to some part of the feathers. They are oval in shape, generally white in color, and often beautifully ornamented with spines and hairs. While laid singly they may be abundant enough to form dense clusters on the fluffy feathers of badly infested chickens. In a few days or weeks the young nymph hatches from the egg in a form much like the parent lice only much smaller and paler in color.

Order Mallaphaga.

Illustration 4-1


SPOROCYSTS
Containing sporozoites
SPOROZOITES
RUPTURED OOCYST
Contents released in intestinal tract.
Attack duodenum, small intestine, ceca or large intestine, depending on the species of Eimeria present.
CHICKS
MATURE FOWL
(Usually acute)
(Usually chronic)
PICKED UP BY CHICKEN FROM GROUND OR LITTER
4 to 7 days after infectious oocysts are picked up, new oocysts are present in the droppings.
INFECTIOUS, SPORULATED OOCYST
Oocyst becomes infectious after about 48 hours of warmth, air and moisture
NON-INFECTIOUS OOCYST

## Chicken Vaccination Outline

The volunteer must determine what diseases are prevalent in the area, which ones can be prevented by vaccines, and whether these vaccines are available for small farmers.

The best resource for this information would be government extension agents, Peace Corps volunteers, and successful farmers in the area.

### Methods of vaccination

eye drop
nasal
water mixture
feather follicle
intramuscular

### Mixture of Vaccine with Water for Drinking

1. Remove water night before vaccination so that birds will consume all the vaccine in the water the next day.

2. If tap water is treated with chlorine, it is best to mix milk with the water, or use from rivers or streams.

3. Increase the number of waterers when vaccinating.

4. Know how many doses the vaccine has, how much water should be mixed, and how many birds are being vaccinted.

Example: 1000 dose vial of vaccine must be mixed with 5 gallons of water according to directions. If you have only 100 chicks to vaccinate you should give only .5 gallons of water mixed with the vaccine.

5. Proper disposal of unused vaccine--vials etc, should be disposed of by fire or burial.

6. Birds should not be receiving any medication when being vaccinated and they should be in proper health.

7. Determine a vaccination schedule based on the least stressful situations.

# Poultry Production Planning

## Recordkeeping

The purpose of this unit or lesson is (1) to allow the trainees to analyze and utilize the records they have kept on the chickens they have raised during training, (2) to emphasize the importance of records and how recordkeeping is one component of production planning.

This is usually the last class during training so that trainees can determine the production level of the chickens they have raised during training.

## Broilers

Broilers are purchased at day old during the beginning of training. Trainees raise and care for them, keeping records on daily feed consumption and weekly weight gain. With this information, the trainees can compare the performance of the flock in feed consumption and weight gain with the chart in Practical Poultry Raising (averge weights and feed consumption for male meat bird). This is from chapter 9, POULTRY MARKETING AND FINANCES, which is good background reading for this lesson.

Trainees also determine what the feed to gain ratio for the flock is both weekly and cumulatively during the project.

## Feed to Gain

Feed to gain means how much feed does the animal have to eat in order to put on one unit of weight gain. (Look at chart on page 155 in P.P.R., last column). For example, if an animal eats two pounds of feed and gains one pound, the feed to gain ratio is 2 to 1. If you look at the above mentioned chart, you will notice that this ratio should be expected at the fifth week (the chart reads 2.08).

Feed to gain ratios are important because they determine the cost of producing a pound of meat, and thus how much profit can be made.

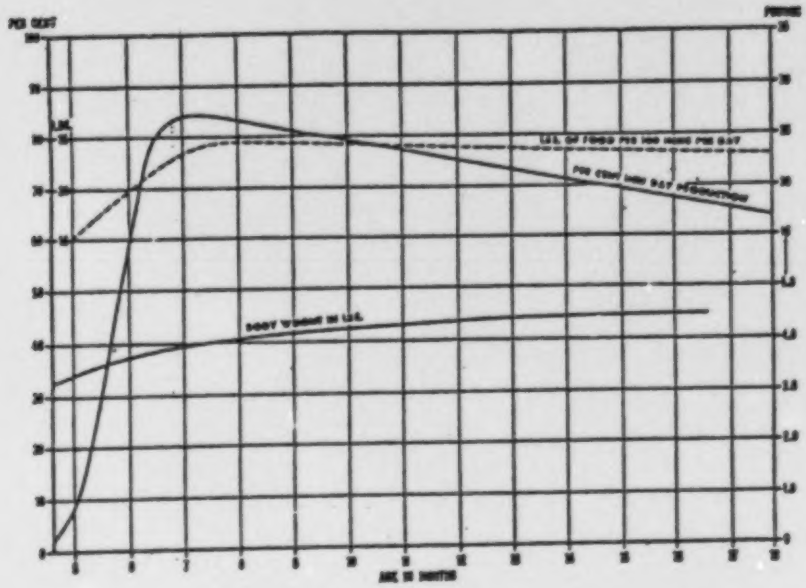
Example: If feed costs \$.10 a pound, and the feed to gain ratio is three, it will cost \$.30 to produce a pound of meat. If you know that 75 percent of your cost in raising broilers is feed cost, then you must sell a pound of meat (live weight) at \$.40. ($.75x = \$.30$, $x = \frac{\$.30}{.75} = \$.40$) in order to break even.

Feed consumption, weight gain, and egg production not only determine whether the project is making money, but the daily health of the flock. Drop in feed consumption is the first sign of possible disease. Egg production, when recorded daily is also a health indicator.

## Egg Producers

Mature egg laying chickens are purchased at the beginning of training. Trainees care for, feed, and keep records on the flock's daily feed consumption and egg production. Unless the age of the flock is known, it is difficult to determine what production should be. Chart A gives the ideal production goals for egg laying chickens. Trainees can determine the daily or monthly egg production of the flock.

CHART A



The above chart indicates the

1. Rate of egg production
2. Body weight
3. Feed Consumption

For high production chickens, the average feed per dozen of eggs is 4.4 lbs. per dozen eggs.

EXAMPLE: If a flock of 12 egg laying chickens produce 6 eggs, production for that day is 50 percent (optimum situation is if each bird lays one egg, then production would be 100 percent). If after one month, the flock produces 180 eggs or 15 dozen, the average egg production for the month is 50 percent. (Optimum situation, or 100 percent is an egg a day x 30 days x 12 birds = 360 eggs; $\frac{180 \text{ eggs}}{360 \text{ eggs}}$ = .5 or 50%). If the flock consumed 6 pounds of feed a day, or 180 lbs. of feed for the month the feed per dozen eggs is 12 lbs ($\frac{180 \text{ lbs.}}{15 \text{ dozen}}$ = 12 lbs/dozen).

According to chart A, the average feed per dozen eggs is 4.4 lbs, so 8 pounds is three times the yearly average. It is difficult to know whether these chickens are doing well unless you know what stage they are in, their laying cycle, and since we do not know the age, we cannot determine this.

EXAMPLE: If laying birds are six months old, under a proper high management situation, birds should be at 50 percent production and feed consumption per 100 hens would be 20 pounds, the feed per dozen eggs is 20 pounds divided by 4.2 dozen (50 eggs), which is 4.8 pounds of feed per dozen eggs. This information was taken from Chart A.

A good example of an egg production record is on page 165 in P.P.R.

Although volunteers may not work in high management and production systems, the principles can still apply to lower systems. Feed ratio is only a general indicator on how well an animal is performing (genetics), what is the quality and quantity of the feed (nutrition), the health of the animal (disease), and whether feed is being wasted, stolen, eaten by rats, etc. (management and housing). The price of a pound of meat or a dozen eggs compared to the cost of a pound of chicken feed is what really determines whether the farmer will make money or not.

EXAMPLE: If it takes 8 pounds of feed to produce a dozen eggs and 8 pounds cost one dollar, the farmer can still make a profit if a dozen is selling for two dollars. Feed to gain usually relates more to cost, and supply and demand developed economics.

Since trainees obtain this information based on their recordkeeping system, they should be able to take a more active role in their training and instill the value of recordkeeping to farmers.

## Genetics, Breeds and Their Purpose

Information concerning this topic has been reviewed in the overview of Livestock Training, Livestock Production Planning and Livestock Production levels, and in Chapter 5, Poultry Husbandry, pages 42-45.

Although it is wiser to select egg and meat breeds when available, the breed's hardiness, adaptability to the area and selected management system, and acceptability among local farmers should also be considered. This author has had better results with improved dual purpose birds in moderate management systems than with specialized egg layers and broilers. Reasons vary.

(1) In parts of West Africa, chicken is prepared by boiling in soups. Broiler meal would tend to fall apart in this cooking process. So, although there may be a market for tender broiler meat in the tourist hotels of large cities and for Africans with western tastes, people in the villages liked an older, tougher chicken.

This need was supplied by a dual purpose bird. After it had laid for about a year, it was economically necessary to sell the bird for meat.

(2) The dual purpose bird appeared to be hardier, less prone to disease, and more adaptable to the environment than white leghorn type breed. Also it was easier to market a larger breed after it finished laying than a smaller one.

(3) Because the broiler industry was not as developed as the egg industry, there was a good market for spent layers (birds finished laying). Also it was a custom to give a live chicken as a gift, especially during the holidays, and the bigger the bird the better the gift.

These observations do not mean to say that dual purpose birds are better for West Africa. These observations do indicate that the volunteer will have to understand the local conditions where he/she is working before applying general advice on what type of breeds to work with.

In dealing with local varieties of chickens (see chapter 4 in Practical Poultry Raising), the volunteer must remember that production of eggs and meat may not be the only objective of the owners. The farmer can be dependent on his chickens for subsistance, instead of the commercial benefits you would expect in developed economies. Chickens could be kept as a sign of wealth and social status. They can also be a form of economic security. Farmers tend to store wealth in material things, including animals, rather than using the banking system. Animals tend to survive better in drought conditions than plants, and can be sacrificed gradually as emergencies arise.

Therefore, volunteers should consider the many objectives that the farmer may have in raising chickens and how trying to improve one may affect the others.

## Poultry Management/Husbandry

Poultry management or husbandry is basically the skill required to raise chickens, usually the improved breeds. Since this is such a vast topic, it would be impossible to cover all topics concerning animal husbandry in this outline.

Although not inclusive, Chapter 5, Poultry Husbandry, in Practical Poultry Raising, covers a good deal of topics.

The management techniques practiced during training are listed below with the chapter/page reference from Practical Poultry Raising.

| FIELD EXERCISE | P.P.R. |
|---|---|
| PREPARATION AND CARE FOR DAY OLD CHICKS | PAGES 55-65 |
| HANDLING LIVE CHICKENS | PAGES 27-29 |
| BROODY HENS | PAGES 46-49 |
| CULLING | PAGES 72-74 |
| FOWL POX VACCINE | PAGES 116-118 |
| POULTRY SLAUGHTER/ DRESSING, POST MORTEM | PAGES 25-26, PAGES 128-130 |

Other possible field exercise that may be included:

| | P.P.R. |
|---|---|
| PREVENTION AND TREATMENT OF COCCIDIOSIS | PAGES 122-124 |
| PREVENTION AND TREATMENT OF PARASITES | PAGES 125-127 |
| CANNIBALISM | PAGES 77-79 |

It should be remembered that some management practices such as culling and brooding can be used with country chickens (native breed) while others may not be appropriate because of cost (vaccines, drugs, etc.)

The volunteer will have to decide what management system farmers are in before she/he recommends a management practice.

## Housing and Equipment

For the level of poultry that most volunteers will work with, Chapter Six, Housing and Equipment, in Practical Poultry Raising, is complete. This supplementation will highlight some of the information covered in this chapter, and discuss some possible problems that may be encountered with government poultry projects.

In determining housing designs, types of waterers, feeders, nest boxes, etc., the volunteer should always be concerned with the appropriateness of the equipment not only for the chickens, but for the farmer as well. The level of production will determine the amount invested in housing and equipment. With small scale farmers, this usually means using the cheapest local resources to build housing and equipment. With underemployment, low labor costs, and extended families being typical situations with small farmers overseas, labor saving devices and methods do not have the same value as they do in more developed countries.

Poultry projects in some developing countries have been poorly planned and managed because they have not considered the appropriateness of the housing and equipment used. For various reasons large expensive poultry houses, like monuments to survive to the end of time, have been constructed, depleting money in the budget needed to feed the animals to be housed. Automatic feeders and waterers have been introduced in areas where unemployment is high. With this sophisticated equipment, there is little provision made or considered for maintenance, repair, and spare parts, which usually have to be imported.

The mentality which causes situations like these can seep into small scale village practices, especially when volunteers have a biased view of what development is and how it comes about.

Besides housing and equipment, Chapter Six deals with the amount of feed consumed and feeder space required (page 100), floor space (pages 87-89), and the amount of water consumed and water space required (page 100). The volunteer must remember that it is not only the type of feeder, waterer, or pen that is important, but whether there is enough space to satisfy the needs of the chickens. This may be a difficult concept to convey to farmers especially if the farmers do not even provide water, feed, or housing for their chickens.

Chickens like all other animals have a social order. This is sometimes called a pecking order. Each chicken fights for dominance and the winner is allowed to peck at the loser. The top chicken will not be pecked. The lower that chicken is on the pecking scale, the more often it will be pecked by the other birds that are higher on the scale. This is one reason to have enough feed, water, and floor space. It allows chickens to eat, drink, and have an opportunity to get away from domineering chickens. If chickens are overcrowded they tend to become cannibalistic (see p. 77-88 in Practical Poultry Raising). Also the amount of space is very important in tropical countries because more is required than is recommended for temperate climates. Chickens cool themselves by burying themselves under the litter (see p. 83 P.P.R.) and drink a lot of water (see p. 101 P.P.R.). The importance of these points cannot be overemphasized. Underestimating the required space is a typical management problem, but one that can be corrected very easily. Farmers can see better weight gains, egg production, and healthier animals not only due to the quality of feed and water, but also because all chickens have access to it with minimal stress involved.

## Comparative Fowl Raising

The objective of this unit is:

1. The trainees review what they have already learned about chickens, in the five components: Genetics or Breeds, Nutrition, Disease, Management, and Housing/Equipment.

2. The trainees apply what they have learned about one animal (chickens) to other animals (ducks and guinea hens).

Because of time contraints and the vast amount of information, it is very difficult for trainers to present, and trainees to absorb, all the skills and information needed to work with animals. This unit basically deals with situations that volunteers might find themselves in overseas. Those situations include working with animals they may not have studied during training and about which they have limited information. The volunteer finds him/herself now more dependent on personal research and self learning, possibly using some of those development worker skills they learned during training.

Learning through analogy works if one knows the right questions to ask. Some of those questions about a new animal, such as poultry, might be:

BREEDS: 1. Are there specific breeds for specific purposes?

NUTRITION: 2. Do these specific purposes require specific diets?

DISEASE: 3. Are there diseases which are pandemic, require vaccines, certain drugs for treatment, zoonotic?

MANAGEMENT: 4. What are the feed to gain ratios? How much feed/water do they need?

HOUSING/EQUIPMENT: 5. What are the feeder, waterer, floor space requirements? Do the animals have to be penned?

By knowing the answers for one animal, one knows what important questions to ask about another. With access to information from development organizations, host country Agricultural Department and Peace Corps (ICE MANUALS), volunteers can find the answers to the important questions. When the information is not adequate, volunteer will have to use analogous answers based on what he/she knows. The volunteer will be responsible for his or her own research. The use of community entry skills, information gathering and filtering, observation and group worker skills, and other development worker tools will facilitate this work.

By taking more responsibility for his/her learning, the volunteer becomes more independent in the learning process. It is believed that one teaches the way one learns. If the volunteer takes more responsibility in the learning process, this quality will hopefully be transfered from volunteer to farmer. Ideally, the farmer becomes more independent in learning, less dependent on the temporary volunteer. Volunteers will sometimes find it frustrating to locate specific information about animals in their village, even animals they have been trained in and know something about. Information is sometimes limited, even in the States, unless the animal in question is part of a large agribusiness which has supported development and research over a period of time. A case in point is the two U.S.D.A. publications referenced on p. 364. There is not much more information on ducks and guinea hens than is contained in these publications.

An example of how to use these publications in comparative learning is shown in the chart below.

Breeds and Their Purpose, High Management

| | CHICKENS | DUCK |
|---|---|---|
| LAYER<br>EGG PRODUCTION | White Leghorn | Khaki Campbell |
| | 1. Feed Efficient | 1. Feed Efficient |
| | 2. Lays about 240 - 300 eggs/year | 2. lays about 300 - 360 eggs/year |
| | 3. Weight 4 lbs. | 3. Weight 4.5 lbs. |
| BROILER<br>MEAT PRODUCTION | White Cornish Cross | White Pekin |
| | 1. Rapidly gains weight | 1. Rapidly gains weight |
| | 2. 3-4 lbs. in 7 - 12 wks | 2. 7 lbs in 8 wks |
| | 3. White feather, makes plucking/dressing easier | 3. White feathers makes plucking/dressing easier |
| BROODINESS<br>NATURAL INCUBATION | Rhode Island Reds | or Muscovies |
| | usually local variety or village birds | 1. Lay 40-50 eggs a year |
| | | 2. 30 ducklings will hatch |
| DUAL PURPOSE<br>EGGS/MEAT | Cross between Rhode Island Reds and Barred Plymouth Rocks | White Pekin |
| | 1. 5-6 lbs. | 1. 160 eggs a year |
| | | 2. 7-9 lbs. after |

The information about the ducks was taken from the U.S.D.A publication, Raising Ducks. The information on chickens has come from various sources during training. The chart emphasizes the similarities. Chart can also be done on other components and topics.

Ducks of course are very similar to chickens, but the same procedure can be done between animals which are not as similar (e.g., chickens and pigs), if the right questions are asked. (e.g., Nutrition: Chickens are monogastrics and have high nutritional demands. Question: Do pigs have the same nutritional demands? Answer: yes, pigs are monogastric).

This method of learning by analogy is an important skill for development workers, whether they are involved in agriculture or not. Volunteers may find out after being at their site for six months that their village has certain needs, and one way of dealing with these needs is personal research and self teaching. Agricultural workers may find out they have time for secondary projects (harvest season) and would need to learn more about certain skills and areas. Learning by analogy can be a valuable tool for any development worker.

For specific information on ducks and guinea hens, check the following publications: "Raising Guinea Fowl", U.S. G.P.O publication 43-14-03521-1, and "Raising Ducks", U.S. G.P.O. publication 0-517-123. Both are available through Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

# FIELD NOTEBOOK OUTLINE - POULTRY

## I. Raising chicks

1. Preparation for receiving chicks
2. Breed
3. Date bought ______ # ______ Date sold ______ # ______
4. Space requirements (floor space, feeders, waterers)
5. Housing (roof, floors, litter, feeders, waterers, lime at entry)
6. Brooding system
7. Vaccination program including: vaccine, date, product, method
8. Control of internal and external parasites (date, product, method)
9. Feeding program (including different rations and their protein level)
10. Locally available foodstuff (include maximum percent permissable in diet)
11. Diseases (if they appear) include: symptoms, causes, and means of control
12. Other (check lists, record sheets, etc.)

## II. Broilers

1. Weight at 7th and 8th week
2. Selling price (amount per kilo)
3. Weekly and total feed consumption and cost
4. Feed conversion rate

## III. Layers

1. Start of laying date
2. Nest space requirements
3. Debeaking (date, method)
4. Culling (date, number culled)
5. Calcium and/or phosphorus source
6. Pounds of feed per dozen eggs
7. Laying rate (include date and expected production)
8. Artificial lighting (system, number hours per day)
9. Molting (system, date started, date of return to maximum production)
10. Vaccination program and parasites control

## GOAT INTRODUCTION

Goats are common in most parts of the world due to their unique ability to adapt to harsh climates. They are the hardiest of the domesticated ruminants and are well adapted to arid and semi-arid climates. They are excellent foragers and local breeds are quite disease resistant. They forage on different plants that are not commonly eaten by sheep and cattle and can therefore be used in companion grazing practices. They are often called "a poor man's cow" because they are less expensive than a cow to purchase and provide a similar function. They can be used to produce mohair, meat, milk, and leather. Because animal husbandry in many developing countries still exists at the subsistence level, the goat is particularly well adapted to these environments because of its hardiness and strong survival instincts. Since the prime goal of the subsistence farmer is to have the animal survive, the goat fits well into the natural scheme. In many cultures the goat may be used as a symbol of wealth, an offering during a religious festival, a gift to the bride's parents, or as a "savings account" to be used for food during times of crop failure and drought. In the U. S. domestic goat production falls into one of three distinct types: (1) Mohair production, (2) Meat production, and (3) Milk production. In subsistence levels of production, the goats being raised often are used for one or more of these types of production at the same time.

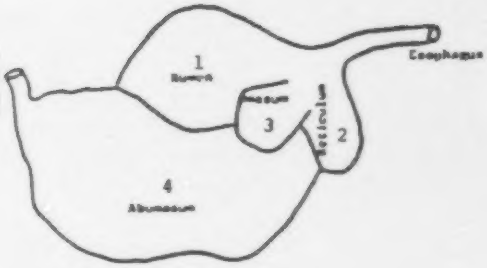
## GOAT NUTRITION

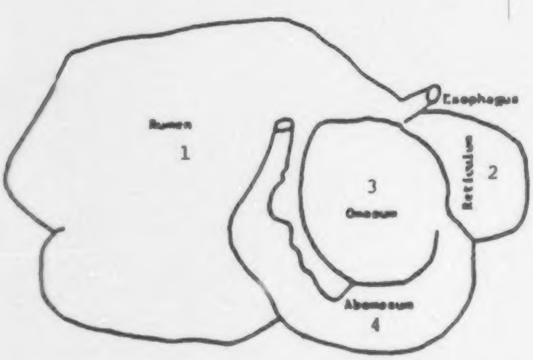
### The Ruminant

The ruminant is a cud chewing animal such as a goat, cow, or sheep having a specialized four-compartmented stomach specially adapted to digest roughages such as grasses, hays, and silages. A ruminant can use up to 50-80% roughages and hays in the diet. The simple stomached animals such as the pig, horse, and human must eat a small amount of bulky feeds and a larger amount of concentrated feeds or grains. Ruminants are well adapted to the New England area because we grow largely roughages here and very little grain.

Following are sketches of four-chambered stomachs of the young calf and the mature cow. The dairy goat relationships between young kids and mature animals would be approximately the same relationship.

## Illustration 5-1





| | Relative Capacity | |
|---|---|---|
| Legend | Calf | Cow |
| 1 - Rumen )<br>2 - Reticulum) | 30% | 85% |
| 3 - Omasum )<br>4 - Abomasum ) | 70% | 15% |

### 1. Rumen

-- This is the largest compartment of the 4 chambered stomach and can hold 4 to 5 gallons of feed at a time.

-- It contains the microflora (bacteria and protozoa) needed for the digestion of forages (grasses and legumes).

These bacteria and protozoa perform the following functions:

-- The microbes of the rumen digest carbohydrates (lignin, cellulose, and hemicellulose) to produce carbon dioxide and volatile fatty acids (such as acetate, propionate, and butyrate).

-- Most of the dietary protein is metabolized or degraded by the bacteria and incorporated as microbial protein.

-- This bacterial protein is then used to form amino acid chains.

-- Nitrogen is used primarily to form these amino acids.

-- These bacteria also synthesize Vitamin K and the B complex.

### 2. Reticulum

-- This "honeycomb" shaped organ becomes the depository for foreign objects (mostly metal, nails, bottle caps, etc.).

-- Aids the rumen in digestion.

### 3. Omasum or Manyplies

-- Absorbs water, grinds food, and pumps food out of the rumen.

### 4. Abomasum

-- This is often called the "true" stomach because its digestive processes are similar to those of the stomach in a monogastric. It is the only compartment of the gastric region of the ruminant containing digestive glands. This compartment is used by the newborn kids to digest milk.

## Foraging: Herbage and Browse

In comparison to other domestic animals, goats have unique preferences for shrubs and tree leaves, whether deciduous or evergreen. Compared with cattle or sheep, they select from a wider array of plants, particularly woody plants. Their pattern of diet selection compares closely with that of deer. Grasses and herbaceous flowering plants (weeds) are also commonly eaten. Because of their unusual preferences for leaves of woody plants, they have been exploited as weapons against encroaching brush species. Early studies in the deciduous woodlands of the U.S. showed that goats would effectively clear undergrowth and will actually kill some trees up to 6 inches in diameter. In East Africa thorn bush areas goats controlled sprouts and regrowth following mechanical control. However, goats do not select only invading plans, and care must be taken to avoid the overstocking that can lead to overgrazing and the destruction of all ground cover. The most successful use of goats in the control of invading plants involves intensive grazing for a short period, followed by removal of all grazing for an extended period to allow for recovery of desirable plants. This method only works when the invading plant is palatable to the goat.

The goat has been seen as a mobile pruning machine that modified bushy shrubs and thereby increased the accessibility of cattle to more nutritious forage. This ability of goats to "beat back the brush" has led to companion grazing of goats with sheep and cattle. This practice is used in the East Africa savannas.

Goats will eat from 6 to 11% of their body weight daily (based on dry matter: DM) of forage. The exact amount they will eat varies depending on climate, temperature, types of browse available (palatability), and the age of the goat.

Goats have an ability to select the high-quality parts of plants that allow them to survive on poor range. In certain instances, the goat may eat large quantities of low-quality feed (such as twigs). The woody portion of the twig is then passed quickly through the intestine, while the more nutritious part is absorbed. Browse (leaves and twigs of shrubs and trees) and weeds contain higher levels of crude protein and phosphorus during the growing season than do grasses. Many palatable browse species, however, are limited in nutrient value because of one or more inhibitors that may bind or otherwise prevent utilization of nutrients contained in the plants. These inhibitors include excessive lignification of woody twigs, and tree leaves that physically bind the nutrients. Essential oils are present at relatively high levels in some range shrubs and may inhibit growth of rumen microflora.

High levels of tanin in some browse may inhibit digestion. Still, goats can do quite well in free range conditions, provided there is adequate browse. It is the ability of the goat to select the most nutritious portion of the plant that makes it such a good survival animal. Furthermore, they do not compete with humans for grains as do the monogastrics (swine and chickens). It must be remembered though that as you place production demands (meat, milk, and growth) on the goat, you must improve the diet of the goat in order for the nutrients to keep pace with the demands of production.

Among the ruminants, goats seem to do the best at digesting high quantities of roughage. Because of its unique ability to digest roughage, the goat offers an opportunity for deriving value from a vast reservoir of natural resources; the unwanted assortment of herbage, shrubs, tree leaves, and plant refuse and their byproducts.

### Energy

The energy requirement of goats depends on the type of production. Maintenance, growth, fattening, pregnancy, and lactation all require different amounts of energy. The Table of Nutrient Requirements (NRC) gives the different energy requirements for (1) Maintenance, (2) Maintenance plus low activity, (3) Maintenance plus medium activity, (4) Maintenance plus high activity, as well as additional requirements for pregnancy, growth, and milk production. The energy requirements are listed in TDN, DE, ME, and NE as well. As goats become larger, the energy needed for maintenance of the body increases leaving less energy available for production. Environmental considerations such as temperature, wind, and humidity also can affect energy requirements. Goats left to pasture will cover twice the ground that sheep and cattle will in a day. Poor pasture or forage conditions can cause a deficiency of energy in the diet of the goat. When such a deficiency exists you may notice: (1) depressed growth, (2) loss of weight, (3) reduced fertility, (4) reduced milk yield, (5) shortended lactation period, (6) reduced resistance to disease and parasites, and (7) a poor coat or reduced mohair production.

Carbohydrates and fats provide nearly all the energy for goats. Much of these carbohydrates and fats come from roughage in the diet. As mentioned earlier, the microflora of the rumen allow the goat to digest the roughage for use as energy. These carbohydrates are converted to volatile fatty acids and absorbed the wall of the rumen.

### Protein

It is a waste of money to provide dietary protein to goats because the bacteria of the rumen break it down to its nitrogenous fragments and then use it to synthesize microbial protein. Goats need only a nitrogen source to synthesize their own protein. For goats in production, it is important to provide only a good supply of nitrogen (obtainable from fresh, green plants). Production of mohair (from Angora goats) and milk both require good diet with an abundance of both protein and energy. To synthesize protein the microbes need nonprotein nitrogen (NPN), sulfur, and sufficient energy. NPN should not be added to the rations of lactating dairy goats because they are subject to urea toxicities. This can occur when urea is fed to does. Cottonseed meal, linseed meal, soybean meal, brewers' dried grains, and alfalfa are common protein supplements for goats. Protein deficiency symptoms include: loss of appetite, loss of weight, poor hair growth, depressed milk producion, and impaired reproduction.

## Water

For goats on dry range, providing adequate water supplies may be a problem. An abundant supply of fresh water is especially important for lactating does. Goats that are not lactating can get by on very little water provided they have access to good, succulent pasture. Depending on body size, level of activity, and climate, a lactating doe can require from 1 to 4 gallons of water daily plus 2-1/2 quarts of water for every quart of milk produced. A lack of water will lower milk production. A running stream is preferrable to standing water which can become contaminated. Water that tastes salty to you will probably not be acceptable to goats.

Table 5-1
Mineral Requirements

| Mineral Which May Be Deficient Under Normal Conditions | Conditions Usually Prevalent Where Deficiencies Are Reported | Function of Mineral | Some Deficiency Symptoms |
|---|---|---|---|
| **Major or macro minerals:**<br>**Salt** (NaCl) | Negligence, for salt is inexpensive.<br>Lactating does may require additional salt as milk contains high amounts of sodium. | Sodium chloride helps maintain osmotic pressure in body cells, upon which depends the transfer of nutrients to the cells, the removal of waste materials, and the maintenance of water balance among the tissues. Also, sodium is important in making bile, which aids in the digestion of fats and carbohydrates; and chlorine is required for the formation of hydrochloric acid in the gastric juice so vital to protein digestion.<br>It is noteworthy that when salt is omitted, sodium expresses its deficiency first. | Loss of appetite, emaciation, decline in milk production, a general rough appearance with poor hair coat and lusterless eyes.<br>Acute deficiency symptoms include shivering, weakness, cardiac disturbances, and ultimately death. |
| **Calcium** | Goats in heavy lactation.<br>Lack of vitamin D.<br>Calcium-deficient areas (where pasture and range forages are deficient in calcium) are Fla., La., Neb., Va., and W. Va.<br>Feeds that contain primarily cereal grains. | Essential for the development and maintenance of good strong bones and teeth; maintains the contractability, rhythm, and tonicity of the heart muscles; antagonizes the action of the sodium and potassium on the heart; is required for normal coagulation of the blood; is necessary for proper nerve irritability; and appears to be essential for selective cellular permeability. | In young kids, retarded growth and abnormal bone development.<br>In lactating does, depressed milk yields and fragile bones.<br>Milk fever can occur when calcium levels in the blood drop. |

| Nutrient Requirements[1] | Recommended Allowances | Practical Sources | Comments |
|---|---|---|---|
| Salt | Salt should be provided free-choice or as a component of the ration. In a complete feed, 0.5% salt is recommended. | Block or loose salt.<br>Iodized salt in iodine-deficient areas.<br>Can be offered free-choice or incorporated into the ration.<br>In alkaline areas, water may contain enough salt to meet the requirements. | In range areas, salt may be added to feed to limit feed intake. If self-feeders are located near water, the level of salt in the ration should be high (25–40%). If self-feeders are some distance from water, the level of salt in the ration should be reduced. |
| Calcium | In many areas, a calcium supplement is mixed with salt at a ratio of 1:1 and offered free-choice. | Ground limestone (calcium), steamed bone meal, dicalcium phosphate. | The recommended ratio of calcium to phosphorus ranges from 2:1 to 4:1. If the ratio falls below 2:1, urinary calculi may develop in males. |

*(Continued)*

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Table 5-1
Mineral Requirements
Page 2

| Mineral Which May Be Deficient Under Normal Conditions | Conditions Usually Prevalent Where Deficiencies Are Reported | Function of Mineral | Some Deficiency Symptoms |
|---|---|---|---|
| **Phosphorus** | When goats subsist on pastures in phosphorus-deficient areas.<br>When goats subsist for long periods on mature, dry forages.<br>Lack of vitamin D. | Essential for sound bones and teeth, and for the assimilation of carbohydrate and fats. A vital ingredient of the proteins in all body cells. Necessary for enzyme activation. Acts as a buffer in blood and tissue. Occupies a key position in biologic oxidation and reactions requiring energy. | Depressed appetite (chewing bones, wood, hair), rickets in young animals, osteomalacia in mature animals, and depressed milk yields in lactating does. |
| **Sulfur** |  | Essential for synthesis of the sulfur amino acids (cystine and methionine). | Depressed appetite, loss of weight, poor growth, depressed milk yields. |
| **Other minerals:**<br>Magnesium, potassium, cobalt, copper, fluorine, iodine, iron, manganese, molybdenum, selenium, and zinc | Little evidence is available indicating deficiencies of these minerals in goats.<br>In areas where the soil is known to be deficient in a particular mineral, supplements of the mineral in question should be either incorporated in the feed or offered in a trace mineral mix. |  | Deficiency symptoms of these minerals have not been reported in goats. |

| Nutrient Requirements[1] | Recommended Allowances | Practical Sources | Comments |
|---|---|---|---|
| Variable according to age, sex, and class (see Table 22-1). |  |  |  |
| Phosphorus | Can be offered free-choice or incorporated into the ration (see Table 22-2). | Cereal grains.<br>Defluorinated phosphate, dicalcium phosphate, steamed bone meal, monosodium phosphate. | Phosphorus is the mineral most likely to be deficient in range forages. It is, therefore recommended that it be supplied in range supplements. |
| Sulfur |  | In the ruminant, organic forms of sulfur are most readily utilized; elemental sulfur is least so; and sulfates are intermediate in this respect. |  |
| Trace Minerals |  | Trace mineralized salt or commercially available supplements of the individual element. |  |

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[1] As used herein, the distinction between "nutrient requirements" and "recommended allowances" is as follows: In nutrient requirements, no margins of safety are included intentionally, whereas in recommended allowances, margins of safety are provided in order to compensate for variations in feed composition, environment, and possible losses during storage or processing.

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## Table 5-2
## Vitamin Requirements

| Vitamin Which May Be Deficient Under Normal Conditions | Conditions Usually Prevalent Where Deficiencies Are Reported | Function of Vitamin | Some Deficiency Symptoms |
|---|---|---|---|
| A | During extended dry periods when the supply of green forage is limited. | Required for normal vision.<br>Aids in reproduction and lactation.<br>Needed for maintaining normal epithelial tissue.<br>Aids in resistance to infection. | Lowered reproductive efficiency.<br>Visual problems.<br>Reduced feed intake.<br>Increased susceptibility to parasites and infections. |
| D | Goats kept in confinement where they have little or no access to sunlight. | Absorption of calcium and phosphorus. | Bone abnormalities.<br>Depressed growth. |
| E | Abnormally high levels of nitrates may produce vitamin E deficiencies.<br>Where soils are very low in selenium. | Serves as a physiological antioxidant, facilitating the absorption and storage of vitamin A. Its other biochemical roles in the animal body appear to be related to its antioxidant capability, including the protection of vitamin A. | May result in reproductive problems or muscular dystrophy. |
| Other vitamins | B vitamin deficiencies may be evident in poorly fed and unhealthy animals.<br>Vitamin K deficiency may occur when the dicumarol content of hay is excessively high, as when moldy sweet clover hay is fed. | Vitamin K or $K_2$ is necessary in the blood clotting mechanism. | |

| Nutrient Requirements[1] | Recommended Allowances | Practical Sources | Comments |
|---|---|---|---|
| Variable according to size, sex, age, and class (see Table 22-1).<br>Vitamin A | Variable according to size, sex, age, and class (see Table 22-2). | Injectable.<br>Stabilized vitamin A.<br>Yellow corn.<br>Green forages. | Young animals, which have not built up vitamin A reserves, are more susceptible to a vitamin A deficiency than are mature animals.<br>Injections, often in combination with vitamins D and E, provide good protection. |
| Vitamin D | | Sunlight.<br>Sun-cured hays.<br>Irradiated yeast.<br>Injectable product. | Vitamin D should be of little concern when goats are maintained on pasture or range. |
| Vitamin E | | Alpha-tocopherol, added to the diet or injected intramuscularly.<br>Grains are generally high in vitamin E. | Most goat rations contain adequate amounts of vitamin E. Hence, there is little need for vitamin E supplementation. |
| Other Vitamins | The B vitamins are not required in the diet of goats with functioning rumens, because the microorganisms synthesize these vitamins in adequate amounts.<br>Vitamin $K_2$ is normally synthesized in large amounts in the rumen; no need for dietary supplementation has been established. | Green leafy materials of any kind, fresh or dry, are good sources of $K_1$. | |

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[1] As used herein, the distinction between "nutrient requirements" and "recommended allowances" is as follows: In nutrient requirements, no margins of safety are included intentionally, whereas in "recommended allowances," margins of safety are provided to compensate for variations in feed composition, environment, and possible losses during storage or processing.

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## Table 5-3
## Table of Nutrient Requirements

### Daily Nutrient Requirements of Goats*

| Body Weight (kg) | Feed Energy |  |  |  | Crude Protein |  |  |  |  |  | Dry Matter per Animal |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  |  |  |  |  | 1 kg = 2.0 Mcal ME |  | 1 kg = 2.4 Mcal ME |  |
|  | TDN (g) | DE (Mcal) | ME (Mcal) | NE (Mcal) | TP (g) | DP (g) | Ca (g) | P (g) | Vitamin A (1000 IU) | Vitamin D IU | Total (kg) | % of kg BW | Total (kg) | % of kg BW |
| *Maintenance only* (includes stable feeding conditions, minimal activity, and early pregnancy) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 10 | 159 | 0.70 | 0.57 | 0.32 | 22 | 15 | 1 | 0.7 | 0.4 | 84 | 0.28 | 2.8 | 0.24 | 2.4 |
| 20 | 267 | 1.18 | 0.96 | 0.54 | 38 | 26 | 1 | 0.7 | 0.7 | 144 | 0.48 | 2.4 | 0.40 | 2.0 |
| 30 | 362 | 1.59 | 1.30 | 0.73 | 51 | 35 | 2 | 1.4 | 0.9 | 195 | 0.65 | 2.2 | 0.54 | 1.8 |
| 40 | 448 | 1.98 | 1.61 | 0.91 | 63 | 43 | 2 | 1.4 | 1.2 | 243 | 0.81 | 2.0 | 0.67 | 1.7 |
| 50 | 530 | 2.34 | 1.91 | 1.08 | 75 | 51 | 3 | 2.1 | 1.4 | 285 | 0.95 | 1.9 | 0.79 | 1.6 |
| 60 | 608 | 2.68 | 2.19 | 1.23 | 86 | 59 | 3 | 2.1 | 1.6 | 327 | 1.09 | 1.8 | 0.91 | 1.5 |
| 70 | 682 | 3.01 | 2.45 | 1.38 | 96 | 66 | 4 | 2.8 | 1.8 | 369 | 1.23 | 1.8 | 1.02 | 1.5 |
| 80 | 754 | 3.32 | 2.71 | 1.53 | 106 | 73 | 4 | 2.8 | 2.0 | 408 | 1.36 | 1.7 | 1.13 | 1.4 |
| 90 | 824 | 3.63 | 2.96 | 1.67 | 116 | 80 | 4 | 2.8 | 2.2 | 444 | 1.48 | 1.6 | 1.23 | 1.4 |
| 100 | 891 | 3.93 | 3.21 | 1.81 | 126 | 86 | 5 | 3.5 | 2.4 | 480 | 1.60 | 1.6 | 1.34 | 1.3 |
| *Maintenance plus low activity* (= 25% increment, intensive management, tropical range and early pregnancy) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 10 | 199 | 0.87 | 0.71 | 0.40 | 27 | 19 | 1 | 0.7 | 0.5 | 108 | 0.36 | 3.6 | 0.30 | 3.0 |
| 20 | 334 | 1.47 | 1.20 | 0.68 | 46 | 32 | 2 | 1.4 | 0.9 | 180 | 0.60 | 3.0 | 0.50 | 2.5 |
| 30 | 452 | 1.99 | 1.62 | 0.92 | 62 | 43 | 2 | 1.4 | 1.2 | 243 | 0.81 | 2.7 | 0.67 | 2.2 |
| 40 | 560 | 2.47 | 2.02 | 1.14 | 77 | 54 | 3 | 2.1 | 1.5 | 303 | 1.01 | 2.5 | 0.84 | 2.1 |
| 50 | 662 | 2.92 | 2.38 | 1.34 | 91 | 63 | 4 | 2.8 | 1.8 | 357 | 1.19 | 2.4 | 0.99 | 2.0 |
| 60 | 760 | 3.35 | 2.73 | 1.54 | 105 | 73 | 4 | 2.8 | 2.0 | 408 | 1.36 | 2.3 | 1.14 | 1.9 |
| 70 | 852 | 3.76 | 3.07 | 1.73 | 118 | 82 | 5 | 3.5 | 2.3 | 462 | 1.54 | 2.2 | 1.28 | 1.8 |
| 80 | 942 | 4.16 | 3.39 | 1.91 | 130 | 90 | 5 | 3.5 | 2.6 | 510 | 1.70 | 2.1 | 1.41 | [illegible] |
| 90 | 1030 | 4.54 | 3.70 | 2.09 | 142 | 99 | 6 | 4.2 | 2.8 | 555 | 1.85 | 2.1 | 1.54 | 1.7 |
| 100 | 1114 | 4.91 | 4.01 | 2.26 | 153 | 107 | 6 | 4.2 | 3.0 | 600 | 2.00 | 2.0 | 1.67 | 1.7 |
| *Maintenance plus medium activity* (= 50% increment, semiarid rangeland, slightly hilly pastures, and early pregnancy) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 10 | 239 | 1.05 | 0.86 | 0.48 | 33 | 23 | 1 | 0.7 | 0.6 | 129 | 0.43 | 4.3 | 0.36 | 3.6 |
| 20 | 400 | 1.77 | 1.44 | 0.81 | 55 | 38 | 2 | 1.4 | 1.1 | 216 | 0.72 | 3.6 | 0.60 | 3.0 |
| 30 | 543 | 2.38 | 1.95 | 1.10 | 74 | 52 | 3 | 2.1 | 1.5 | 294 | 0.98 | 3.3 | 0.81 | 2.7 |
| 40 | 672 | 2.97 | 2.42 | 1.36 | 93 | 64 | 4 | 2.8 | 1.8 | 363 | 1.21 | 3.0 | 1.01 | 2.5 |
| 50 | 795 | 3.51 | 2.86 | 1.62 | 110 | 76 | 4 | 2.8 | 2.1 | 429 | 1.43 | 2.9 | 1.19 | 2.4 |
| 60 | 912 | 4.02 | 3.28 | 1.84 | 126 | 87 | 5 | 3.5 | 2.5 | 492 | 1.64 | 2.7 | 1.37 | 2.3 |
| 70 | 1023 | 4.52 | 3.68 | 2.07 | 141 | 98 | 6 | 4.2 | 2.8 | 552 | 1.84 | 2.6 | 1.53 | 2.2 |
| 80 | 1131 | 4.98 | 4.06 | 2.30 | 156 | 108 | 6 | 4.2 | 3.0 | 609 | 2.03 | 2.5 | 1.69 | 2.1 |
| 90 | 1236 | 5.44 | 4.44 | 2.50 | 170 | 118 | 7 | 4.9 | 3.3 | 666 | 2.22 | 2.5 | 1.85 | 2.0 |
| 100 | 1336 | 5.90 | 4.82 | 2.72 | 184 | 128 | 7 | 4.9 | 3.6 | 723 | 2.41 | 2.4 | 2.01 | 2.0 |

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From: Nutrient Requirements of Goats, The National Research Council, National Academy of Science Press, 1981.

Table 5-3
Table of Nutrient Requirements
Page 2

| Body Weight (kg) | Feed Energy | | | | Crude Protein | | Ca (g) | P (g) | Vitamin A (1000 IU) | Vitamin D IU | Dry Matter per Animal | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | 1 kg = 2.0 Mcal ME | | 1 kg = 2.4 Mcal ME | |
| | TDN (g) | DE (Mcal) | ME (Mcal) | NE (Mcal) | TP (g) | DP (g) | | | | | Total (kg) | % of kg BW | Total (kg) | % of kg BW |
| *Maintenance plus high activity* (= 75% increment, arid rangeland, sparse vegetation, mountainous pastures, and early pregnancy) | | | | | | | | | | | | | | |
| 10 | 278 | 1.22 | 1.00 | 0.56 | 38 | 26 | 2 | 1.4 | 0.8 | 150 | 0.50 | 5.0 | 0.42 | 4.2 |
| 20 | 467 | 2.06 | 1.68 | 0.94 | 64 | 45 | 2 | 1.4 | 1.3 | 252 | 0.84 | 4.2 | 0.70 | 3.5 |
| 30 | 634 | 2.78 | 2.28 | 1.28 | 87 | 60 | 3 | 2.1 | 1.7 | 342 | 1.14 | 3.8 | 0.95 | 3.2 |
| 40 | 784 | 3.46 | 2.82 | 1.59 | 108 | 75 | 4 | 2.8 | 2.1 | 423 | 1.41 | 3.5 | 1.18 | 3.0 |
| 50 | 928 | 4.10 | 3.34 | 1.89 | 128 | 89 | 5 | 3.5 | 2.5 | 501 | 1.67 | 3.3 | 1.39 | 2.7 |
| 60 | 1064 | 4.69 | 3.83 | 2.15 | 146 | 102 | 6 | 4.2 | 2.9 | 576 | 1.92 | 3.2 | 1.60 | 2.7 |
| 70 | 1194 | 5.27 | 4.29 | 2.42 | 165 | 114 | 6 | 4.2 | 3.2 | 642 | 2.14 | 3.0 | 1.79 | 2.6 |
| 80 | 1320 | 5.81 | 4.74 | 2.68 | 182 | 126 | 7 | 4.9 | 3.6 | 711 | 2.37 | 3.0 | 1.98 | 2.5 |
| 90 | 1442 | 6.35 | 5.18 | 2.92 | 198 | 138 | 8 | 5.6 | 3.9 | 777 | 2.59 | 2.9 | 2.16 | 2.4 |
| 100 | 1559 | 6.88 | 5.62 | 3.17 | 215 | 150 | 8 | 5.6 | 4.2 | 843 | 2.81 | 2.8 | 2.34 | 2.3 |
| *Additional requirements for late pregnancy* (for all goat sizes) | | | | | | | | | | | | | | |
| | 397 | 1.74 | 1.42 | 0.80 | 82 | 57 | 2 | 1.4 | 1.1 | 213 | 0.71 | | 0.59 | |
| *Additional requirements for growth—weight gain at 50 g per day* (for all goat sizes) | | | | | | | | | | | | | | |
| | 100 | 0.44 | 0.36 | 0.20 | 14 | 10 | 1 | 0.7 | 0.3 | 54 | 0.18 | | 0.15 | |
| *Additional requirements for growth—weight gain at 100 g per day* (for all goat sizes) | | | | | | | | | | | | | | |
| | 200 | 0.88 | 0.72 | 0.40 | 28 | 20 | 1 | 0.7 | 0.5 | 108 | 0.36 | | 0.30 | |
| *Additional requirements for growth—weight gain at 150 g per day* (for all goat sizes) | | | | | | | | | | | | | | |
| | 300 | 1.32 | 1.08 | 0.60 | 42 | 30 | 2 | 1.4 | 0.8 | 162 | 0.54 | | 0.45 | |
| *Additional requirements for milk production per kg at different fat percentages* (including requirements for nursing single, twin or triplet kids at the respective milk production level) | | | | | | | | | | | | | | |
| (% Fat) | | | | | | | | | | | | | | |
| 2.5 | 333 | 1.47 | 1.20 | 0.68 | 59 | 42 | 2 | 1.4 | 3.8 | 760 | | | | |
| 3.0 | 337 | 1.49 | 1.21 | 0.68 | 64 | 45 | 2 | 1.4 | 3.8 | 760 | | | | |
| 3.5 | 342 | 1.51 | 1.23 | 0.69 | 68 | 48 | 2 | 1.4 | 3.8 | 760 | | | | |
| 4.0 | 346 | 1.53 | 1.25 | 0.70 | 72 | 51 | 3 | 2.1 | 3.8 | 760 | | | | |
| 4.5 | 351 | 1.55 | 1.26 | 0.71 | 77 | 54 | 3 | 2.1 | 3.8 | 760 | | | | |
| 5.0 | 356 | 1.57 | 1.28 | 0.72 | 82 | 57 | 3 | 2.1 | 3.8 | 760 | | | | |
| 5.5 | 360 | 1.59 | 1.29 | 0.73 | 86 | 60 | 3 | 2.1 | 3.8 | 760 | | | | |
| 6.0 | 365 | 1.61 | 1.31 | 0.74 | 90 | 63 | 3 | 2.1 | 3.8 | 760 | | | | |
| *Additional requirements for mohair production by Angora at different production levels* | | | | | | | | | | | | | | |
| Annual Fleece Yield (kg) | | | | | | | | | | | | | | |
| 2 | 16 | 0.07 | 0.06 | 0.03 | 9 | 6 | | | | | | | | |
| 4 | 34 | 0.15 | 0.12 | 0.07 | 17 | 12 | | | | | | | | |
| 6 | 50 | 0.22 | 0.18 | 0.10 | 26 | 18 | | | | | | | | |
| 8 | 66 | 0.29 | 0.24 | 0.14 | 34 | 24 | | | | | | | | |

[a] Definitions of terms and equations used are in Chapter 2.

From: Nutrient Requirements of Goats, The National Research Council, National Academy of Science Press, 1981.

## Table 5-4
## Ration Formulation and Examples of Typical Rations

### 1. EXAMPLE RATIONS FOR MAINTENANCE

A. *For a 30 kg goat in tropical areas in a nonproductive state with maintenance only and minimal activity.*

**Total Requirements (from Table 1):** 1.59 Mcal DE/day
51.0 g TP/day

**Ration**

| | DM basis | | | As-fed basis | | |
|---|---|---|---|---|---|---|
| Feeds | Amount (g) | DE (Mcal) | TP (g) | DM (%) | Amount (g) | % of ration |
| Chickpea (Gram), straw | 620 | 1.36 | 33 | 91 | 681 | 65 |
| Alfalfa, fresh | 95 | 0.23 | 19 | 26 | 365 | 35 |
| Total | 715 | 1.59 | 52 | — | 1,046 | 100 |

Composition of ration: DE = 2.22 Mcal/kg DM
TP = 7.3% of DM
Level of intake (DM): 2.4% of body weight

B. *For a 50 kg goat in tropical areas in a nonproductive state with maintenance only and minimal activity.*

**Total Requirements (from Table 1):** 2.34 Mcal DE/day
75 g TP/day

**Ration**

| | DM basis | | | As-fed basis | | |
|---|---|---|---|---|---|---|
| Feeds | Amount (g) | DE (Mcal) | TP (g) | DM (%) | Amount (g) | % of ration |
| Wheat straw | 716 | 1.40 | 26 | 89 | 804 | 30 |
| Alexandrian clover (Berseem), fresh | 333 | 0.94 | 56 | 18 | 1,850 | 70 |
| Total | 1,049 | 2.34 | 82 | — | 2,654 | 100 |

Composition of ration: DE = 2.23 Mcal/kg DM
TP = 7.8% of DM
Level of intake (DM): 2.1% of body weight

### 2. EXAMPLE RATIONS FOR LIVEWEIGHT GAIN

A. *For a 20 kg growing animal with minimal body activity gaining 50 g per day.*

**Total Requirements (from Table 1)**

| | | |
|---|---|---|
| Maintenance | 1.18 Mcal DE/day | 38 g TP/day |
| Growth | 0.44 | 14 |
| Total | 1.62 | 52 |

**Ration**

| | DM basis | | | As-fed basis | | |
|---|---|---|---|---|---|---|
| Feeds | Amount (g) | DE (Mcal) | TP (g) | DM (%) | Amount (g) | % of ration |
| Alfalfa hay, full bloom | 80 | 0.19 | 14 | 19 | 88 | 18 |
| Corn grain | 360 | 1.44 | 38 | 87 | 414 | 82 |
| Total | 445 | 1.66 | 52 | — | 502 | 100 |

Composition of ration: DE = 3.73 Mcal/kg DM
TP = 11.7% of DM
Level of intake (DM): 2.2% of body weight

B. *For a 30 kg growing goat with minimal body activity gaining 150 g per day.*

**Total Requirements (from Table 1)**

| | | |
|---|---|---|
| Maintenance | 1.59 Mcal DE/day | 51 g TP/day |
| Growth | 1.32 | 42 |
| Total | 2.91 | 93 |

**Ration**

| | DM basis | | | As-fed basis | | |
|---|---|---|---|---|---|---|
| Feeds | Amount (g) | DE (Mcal) | TP (g) | DM (%) | Amount (g) | % of ration |
| Chickpea straw | 500 | 1.10 | 26 | 91 | 549 | 51 |
| Corn grain | 400 | 1.60 | 42 | 87 | 460 | 42 |
| Linseed oilmeal | 65 | 0.23 | 25 | 90 | 72 | 7 |
| Total | 965 | 2.93 | 93 | — | 1,081 | 100 |

Composition of ration: DE = 3.03 Mcal/kg DM
TP = 9.6% of DM
Level of intake (DM): 3.2% of body weight

## 3. EXAMPLE RATIONS FOR PREGNANT DOES

A. *For a 30 kg doe in late gestation and having minimal activity.*

Total Requirements (from Table 1)

| | | |
|---|---|---|
| Maintenance | 1.59 Mcal DE/day | 51 g TP/day |
| Pregnancy | 1.74 | 56 |
| Total | 3.33 | 107 |

Ration

| | DM basis | | | As-fed basis | | |
|---|---|---|---|---|---|---|
| Feeds | Amount (g) | DE (Mcal) | TP (g) | DM (%) | Amount (g) | % of ration |
| Wheat straw | 500 | 0.98 | 18 | 89 | 562 | 25 |
| Oat silage | 365 | 1.00 | 35 | 30 | 1,216 | 55 |
| Barley grain | 400 | 1.44 | 53 | 90 | 444 | 20 |
| Total | 1,265 | 3.42 | 106 | — | 2,222 | 100 |

Composition of ration: DE = 2.70 Mcal/kg DM
TP = 8.4% of DM
Level of intake (DM): 4.2% of body weight

B. *For a 40 kg doe in late gestation and with minimal activity.*

Total Requirements (from Table 1)

| | | |
|---|---|---|
| Maintenance | 1.98 Mcal DE/day | 63 g TP/day |
| Pregnancy | 1.74 | 56 |
| Total | 3.72 | 119 |

Ration

| | DM basis | | | As-fed basis | | |
|---|---|---|---|---|---|---|
| Feeds | Amount (g) | DE (Mcal) | TP (g) | DM (%) | Amount (g) | % of ration |
| Johnsongrass hay, mature | 960 | 2.36 | 91 | 91 | 1,055 | 73 |
| Sorghum grain | 350 | 1.35 | 40 | 89 | 393 | 27 |
| Total | 1,310 | 3.71 | 131 | — | 1,448 | 100 |

Composition of ration: DE = 2.83 Mcal/kg DM
TP = 10.0% of DM
Level of intake (DM): 3.3% of body weight

## 4. EXAMPLE RATIONS FOR LACTATING DOES

A. *For a 30 kg doe producing 1 kg of milk testing 4% fat and having minimal activity.*

Total Requirements (from Table 1)

| | | |
|---|---|---|
| Maintenance | 1.59 Mcal DE/day | 51 g TP/day |
| Lactation | 1.53 | 72 |
| Total | 3.12 | 123 |

Ration

| | DM basis | | | As-fed basis | | |
|---|---|---|---|---|---|---|
| Feeds | Amount (g) | DE (Mcal) | TP (g) | DM (%) | Amount (g) | % of ration |
| Alexandrian clover (Berseem), hay | 500 | 1.42 | 76 | 88 | 568 | 49 |
| Molasses, cane | 200 | 0.70 | 12 | 74 | 270 | 23 |
| Cassava, chips | 200 | 0.79 | 7 | 81 | 247 | 21 |
| Peanut oil-meal | 60 | 0.21 | 31 | 92 | 65 | 7 |
| Total | 960 | 3.12 | 126 | — | 1,150 | 100 |

Composition of ration: DE = 3.25 Mcal/kg DM
TP = 13.1% of DM
Level of intake (DM): 3.2% of body weight

B. *For a 70 kg goat producing 5 kg of milk testing 3.5% fat and with minimal activity.*

Total Requirements (from Table 1)

| | | |
|---|---|---|
| Maintenance | 3.01 Mcal DE/day | 96 g TP/day |
| Lactation | 7.55 | 340 |
| Total | 10.56 | 436 |

Ration

| | DM basis | | | As-fed basis | | |
|---|---|---|---|---|---|---|
| Feeds | Amount (g) | DE (Mcal) | TP (g) | DM (%) | Amount (g) | % of ration |
| Corn silage, dough stage | 1,000 | 2.92 | 77 | 27 | 3,704 | 60 |
| Alfalfa hay, full bloom | 500 | 1.18 | 85 | 91 | 549 | 9 |
| Corn grain | 1,365 | 5.45 | 145 | 87 | 1,569 | 26 |
| Soybean oilmeal | 280 | 1.09 | 130 | 90 | 311 | 5 |
| Total | 3,145 | 10.64 | 437 | — | 6,133 | 100 |

Composition of ration: DE = 3.38 Mcal/kg DM
TP = 13.9% of DM
Level of intake (DM): 4.5% of body weight

C. *For a 60 kg goat producing 6 kg of milk testing 3.5% fat and having a low level of activity.*

Total Requirements (from Table 1)

| | | |
|---|---|---|
| Maintenance | 3.35 Mcal DE/day | 105 g TP/day |
| Lactation | 9.06 | 408 |
| Total | 12.41 | 513 |

Ration

| | DM basis | | | As-fed basis | | |
|---|---|---|---|---|---|---|
| Feeds | Amount (g) | DE (Mcal) | TP (g) | DM (%) | Amount (g) | % of ration |
| Mixed grass hay | 500 | 1.30 | 38 | 89 | 562 | 14 |
| Corn grain | 1,700 | 6.78 | 180 | 87 | 1,954 | 50 |
| 25% protein supplement | 1,200 | 4.40 | 300 | 85 | 1,412 | 36 |
| Total | 3,400 | 12.48 | 518 | — | 3,928 | 100 |

Composition of ration: DE = 3.67 Mcal/kg DM
TP = 15.2% of DM
Level of intake (DM): 5.7% of body weight

## 5. EXAMPLE RATIONS FOR ANGORA GOATS

A. *For a 30 kg nonpregnant, nonlactating doe having medium activity and producing mohair at a rate of 4 kg per year.*

Total Requirements (from Table 1)

| | | |
|---|---|---|
| Maintenance | 2.38 Mcal DE/day | 74 g TP/day |
| Mohair | 0.15 | 17 |
| Total | 2.53 | 91 |

Ration

| | DM basis | | | As-fed basis | | |
|---|---|---|---|---|---|---|
| Feeds | Amount (g) | DE (Mcal) | TP (g) | DM (%) | Amount (g) | % of ration |
| Johnsongrass hay | 600 | 1.44 | 46 | 91 | 659 | 67 |
| Sorghum grain | 252 | 0.97 | 29 | 89 | 283 | 29 |
| Cottonseed oilmeal | 34 | 0.13 | 16 | 90 | 38 | 4 |
| Total | 886 | 2.54 | 91 | — | 980 | 100 |

Composition of ration: DE = 2.87 Mcal/kg DM
TP = 10.3% of DM
Level of intake (DM): 3.0% of body weight

B. *For a 20 kg goat kid gaining 100 g/day, having low body activity and producing mohair at a rate of 2 kg per year.*

Total Requirements (from Table 1)

| | | |
|---|---|---|
| Maintenance | 1.47 Mcal DE/day | 46 g TP/day |
| Growth | 0.88 | 28 |
| Mohair | 0.07 | 9 |
| Total | 2.42 | 83 |

Ration

| | DM basis | | | As-fed basis | | |
|---|---|---|---|---|---|---|
| Feeds | Amount (g) | DE (Mcal) | TP (g) | DM (%) | Amount (g) | % of ration |
| Alfalfa hay, mature | 250 | 0.59 | 33 | 91 | 275 | 32 |
| Corn grain | 441 | 1.76 | 47 | 87 | 507 | 60 |
| Molasses, cane | 50 | 0.17 | 3 | 74 | 68 | 8 |
| Total | 741 | 2.52 | 83 | — | 850 | 100 |

Composition of ration: DE = 3.40 Mcal/kg DM
TP = 11.2% of DM
Level of intake (DM): 3.7% of body weight

C. *For a 40 kg pregnant doe having low body activity and producing mohair at a rate of 6 kg per year.*

Total Requirements (from Table 1)

| | | |
|---|---|---|
| Maintenance | 2.47 Mcal DE/day | 77 g TP/day |
| Pregnancy | 1.74 | 56 |
| Mohair | 0.22 | 26 |
| Total | 4.43 | 159 |

Ration

| | DM basis | | | As-fed basis | | |
|---|---|---|---|---|---|---|
| Feeds | Amount (g) | DE (Mcal) | TP (g) | DM (%) | Amount (g) | % of ration |
| Alfalfa hay, mature | 700 | 1.66 | 93 | 91 | 769 | 48 |
| Corn grain | 630 | 2.51 | 67 | 87 | 724 | 46 |
| Molasses, cane | 75 | 0.26 | 4 | 74 | 101 | 6 |
| Total | 1,405 | 4.43 | 164 | — | 1,594 | 100 |

Composition of ration: DE = 3.15 Mcal/kg DM
TP = 11.7% of DM
Level of intake (DM): 3.5% of body weight

D. *For a 30 kg doe having high body activity, nursing at the rate of 1 kg of milk production of 4% fat per day, and producing mohair at a rate of 4 kg per year.*

Total Requirements (from Table 1)

| | | |
|---|---|---|
| Maintenance | 2.78 Mcal DE/day | 74 g TP/day |
| Lactation | 1.53 | 72 |
| Mohair | 0.07 | 9 |
| Total | 4.38 | 155 |

Ration

| | DM basis | | | As-fed basis | | |
|---|---|---|---|---|---|---|
| Feeds | Amount (g) | DE (Mcal) | TP (g) | DM (%) | Amount (g) | % of ration |
| Johnsongrass hay | 400 | 0.98 | 30 | 91 | 440 | 28 |
| Alfalfa hay, mature | 400 | 0.95 | 53 | 91 | 440 | 28 |
| Corn grain | 600 | 2.39 | 64 | 87 | 690 | 42 |
| Cottonseed oilmeal | 20 | 0.08 | 9 | 91 | 22 | 2 |
| Total | 1,420 | 4.40 | 156 | — | 1,592 | 100 |

Composition of ration: DE = 3.1 Mcal/kg DM
TP = 11.0% of DM
Level of intake (DM): 4.7% of body weight

## 6. OTHER EXAMPLE RATIONS FOR GOATS IN TEMPERATE AND TROPICAL REGIONS AND FOR ANGORA GOATS

### A. *Temperate regions*

Does: pregnant or dry
  Example 1:
    pasture plus good mixed hay and
    0.5 kg of a 16% protein supplement
  Example 2:
    0.5 kg silage
    0.5 kg mixed hay
    0.3 kg beet pulp
    0.5 kg 16% protein supplement
  Example 3:
    1.0 kg beets
    0.5 kg alfalfa hay
    0.5 kg beet pulp
    0.5 kg 16% protein supplement

Does: lactating
  Example 1:
    1.5 kg clover hay
    2.0 kg 14% protein supplement
  Example 2:
    1.5 kg grass legume hay
    2.5 kg 16% protein supplement
  Example 3:
    0.5 kg mixed hay
    2.5 kg corn silage
    2.0 kg 18% protein supplement
  Example 4:
    3.0 kg roots, beets, carrots, steamed potatoes
    1.5 kg mixed hay
    0.25 kg beet pulp
    0.5 kg oats straw
    1.0 kg 14% protein supplement
  Example 5:
    2.0-4.0 kg green chop, pasture
    1.5 kg sugar beet leaf silage
    0.5 kg alfalfa hay
    0.7 kg beet pulp
    0.45 kg 14% protein supplement

Kids: nursing

Colostrum on the 1st day, 0.25 to 1.0 kg milk 2 to 3 times a day according to size for six to nine weeks, plus 16% protein supplement consisting of coarse grain, steamed rolled corn, oats, barley, pelleted alfalfa leaf meal, molasses (not more than 10%), and grass hays *ad libitum*

Kids: weaned and yearlings

Good mixed hay *ad libitum*, plus 0.25 to 0.75 kg of 16% protein supplement consisting of coarse grain mixtures and pasture

Bucks: breeding
(out of season)
  Good hays *ad libitum* and pasture
(in season)
  0.5 to 1.0 kg of a 14% protein supplement, plus mineral supplementation and salt, plus good hays and pasture

B. *Tropical regions*

Postweaning growth and meat production:

- Example 1 (India):
  - 50% cereal straw
  - 30% corn grain
  - 20% Alexandrian clover (Berseem), green
- Example 2 (India):
  - 40% cereal straw
  - 30% oat silage
  - 25.5% corn grain
  - 4.5% linseed oilmeal
- Example 3 (Nigeria):
  - 79.3% cassava flour
  - 15.2% molasses
  - 5.5% urea

Pregnant doe (India):

- 40% cereal straw
- 30% oat silage
- 23.5% barley grain
- 6.5% peanut oilmeal

Supplements for milk production (fed at pasture):

- Example 1 (India):
  - 45% corn grain
  - 35% Alexandrian clover, (Berseem)
  - 20% cereal straw
- Example 2 (West Indies):
  - 34% coconut meal cake
  - 20% wheat middlings
  - 20% molasses
  - 15% citrus meal
  - 10% soybean oilmeal
  - 1% mineral mix
- Example 3 (Malaysia):
  - 40% wheat flour
  - 34% rice bran
  - 12% peanut oilmeal
  - 10% coconut meal cake
  - 2% molasses
  - 2% mineral mix
- Example 4 (Mexico):
  - 44% sorghum grain
  - 37% corn grain
  - 10% soybean oilmeal
  - 6% molasses
  - 1% urea
  - 2% salt and mineral mix

C. *Angora goats*

Growing kids and yearlings:

- 32% alfalfa hay
- 28% cottonseed hulls
- 18% sorghum grain
- 8% barley grain
- 6% molasses
- 6% cottonseed oilmeal
- 2% salt and mineral mix

Lactating does:

- 47% alfalfa hay
- 20% cottonseed hulls
- 15% sorghum grain
- 8% barley grain
- 6% molasses
- 2% cottonseed oilmeal
- 2% salt and mineral mix

7. EXAMPLE PROTEIN SUPPLEMENTS (PERCENT OF RATION)

| | Total protein content | | |
|---|---|---|---|
| | 14% | 16% | 18% |
| Corn grain | 37 | 35 | 32 |
| Oats grain | 37 | 35 | 32 |
| Wheat bran | 16 | 14 | 15 |
| Oilmeal, soybean, linseed | 9 | 15 | 20 |
| Dicalcium phosphate | 0.5 | 0.5 | 0.5 |
| Trace mineral salt | 0.5 | 0.5 | 0.5 |
| Total | 100 | 100 | 100 |

## Determining the Weight of Goats

Determining a goat's weight by measuring its heartgirth (chest) is an important technique for the volunteer who will be working in the field with goats. Being able to determine the weight of a goat is important as shown in the following examples.

1. Most medications for goats give the dosage in terms of mg. per pound of body weight. Often it would not be possible to know the needed dosage for a goat without knowing its body weight.
2. In order for the volunteer to know the value of a goat (for purposes of buying and selling) you must know the weight in order to determine a price per pound. Without knowing the weight of the goat and the local price it would be easy for a trader to take advantage of the volunteer.
3. In order to determine weight gain over a period of time of a goat, the volunteer will need to know this technique since scales for animals may not be a common item locally. This knowledge of weight gain is important because it provides information about the net result of management and feeding practices.

Measuring the heartgirth is a simple procedure. The first step is to restrain the goat. You can wedge the goat tightly against a fence or restrain it in the easiest manner possible and then use a tape measure to measure its chest directly behind the forelegs. The circumference of the chest (in inches) can then be located on the chart which will give you the corresponding weight of the goat.

Table 5-5
Weight Chart for Goats

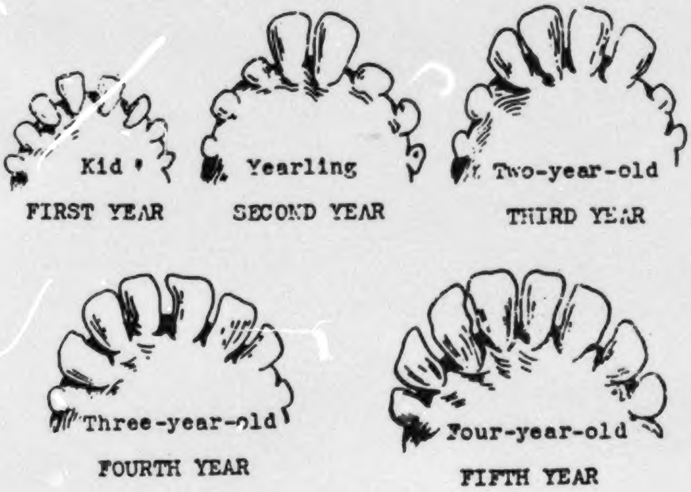
| Inches around heart girth | Pounds |
|---|---|
| 10.25 | 4.5 |
| 10.75 | 5 |
| 11.25 | 5.5 |
| 11.75 | 6 |
| 12.25 | 6.5 |
| 12.75 | 7 |
| 13.25 | 8 |
| 13.75 | 9 |
| 14.25 | 10 |
| 14.75 | 11 |
| 15.25 | 12 |
| 15.75 | 13 |
| 16.25 | 15 |
| 16.75 | 17 |
| 17.25 | 19 |
| 17.75 | 21 |
| 18.25 | 23 |
| 18.75 | 25 |
| 19.25 | 27 |
| 19.75 | 29 |
| 20.25 | 31 |
| 20.75 | 33 |
| 21.25 | 35 |
| 21.75 | 37 |
| 22.25 | 39 |
| 22.75 | 42 |
| 23.25 | 45 |
| 23.75 | 48 |
| 24.25 | 51 |
| 24.75 | 54 |
| 25.25 | 57 |
| 25.75 | 60 |
| 26.25 | 63 |
| 26.75 | 66 |
| 27.25 | 69 |
| 27.75 | 72 |
| 28.25 | 75 |
| 28.75 | 78 |
| 29.25 | 81 |
| 29.75 | 84 |
| 30.25 | 87 |
| 30.75 | 90 |
| 31,25 | 90 |
| 31.75 | 97 |
| 32.25 | 101 |
| 32.75 | 105 |
| 33.25 | 110 |
| 33.75 | 115 |
| 34.25 | 120 |

## Determining the Age of Goats

It should be recognized that there is considerable variation in individual animals and the teeth are only a rough guide as to actual age.

Goats have eight front teeth on the lower front jaw. These teeth are small and sharp in animals less than one year of age. At about one year, the center pair of teech will drop out and are replaced by two large permanent teeth. At about the 24th month, two more large front teech appear, one on each side of the first two yearling teeth. The three to four year old has six permanent teeth, two more than the two year old and these come in one on each side of the two year old teeth. The four to five year olds have a complete set of eight permanent teeth. After this age, the approximate age can be told by the amount of wear in the front teeth. As the animal gets older, the teeth spread apart and finally become loose and some drop out. At this age, the animal begins to lose its usefulness as a grazing animal. It may be kept on and fed specially prepared feeds, if the animal is still capable of reproduction.

Illustration 5-2



Being able to determine the age of the goat by examining the teeth is an important skill for the volunteer. Knowing the age of the goat is important because the age of the animal will affect decisions the volunteer makes about:

1. Buying and selling
2. Production concerns
3. Diet and breeding

## Castration

Castration of buck (male kids) should occur within the first month of life. Bucks that are to be raised for meat and not kept for breeding purposes need to be castrated. Castration early in life minimizes the stress placed on the young buck and allows the buck to recover more quickly with a reduced chance of infection. Depending on the cultural practices of your area, a local farmer may also practice disbudding (removal of the horn) at the same time they castrate. Avoid the cold and damp days for castrating young bucks and, if possible, provide dry bedding for a few days. Cultural practices will vary in different countries concerning castration; but some cultures prefer meat of castrated bucks to uncastrated because it has less of a "gamy" or wild flavor.

Young goats can be castrated without anesthesia. To castrate, you cut off the bottom third of the scrotum sack with a sharp knife. This should be preceeded by washing of the scrotum if it is dirty. Then place pressure on the testicles (one at a time) above the cut and force the testicle out of the end of the scrotum. Grasp the testicle, pull it out of the scrotum, and then with a sharp knife or scissors, cut the connecting tissue thus removing the testicle. Repeat this procedure on the second testicle. Then apply a disinfectant such as iodine or alcohol to the wound. Continue to check on the buck for 2 or 3 days following the castration for signs of infection. If possible, give a shot of tetanus antitoxin (150 to 200 i.u.) after castration. If an infection occurs, use a disinfectant to recleanse the wound and, if necessary, give an injection of an antibiotic. If screwworms are a problem in the area, you can apply an insecticide such as Lindane when mixed in a commercial ointment or simply apply a heavy petroleum grease to the wound.

## Hoof Trimming

Trimming of hooves is a very important skill. Hooves of goats that are allowed to become overgrown can cripple the goat. It is an inexpensive practice since it involves nothing more than time and a sharp knife. Also, goats will not thrive or gain weight if their feet are neglected.

For goats being raised on rocky ground and allowed to roam free, you rarely, if ever, need to trim their hooves because they continually grind them down. However, for goats raised on soft soil or in confinement, you will need to trim their hooves regularly.

The hoof has no feeling and trimming a hoof can be compared to trimming fingernails. The goat will feel no pain if you do the work properly. The idea is to trim away all the excess thereby providing a flat underside to the hoof for the goat to walk on. One, large, sharp knife is all that's needed. Start by trimming away the obvious excess and continue to trim until the bottom of the hoof is flat. When the hoof appears pinkish, rather than white, at the point you are cutting you have gone deep enough. It is a technique that requires practice in order to be proficient.

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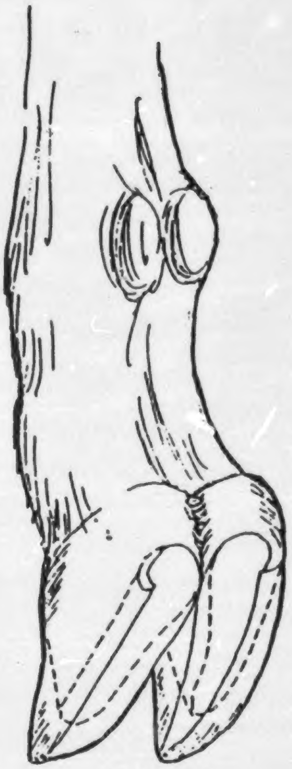
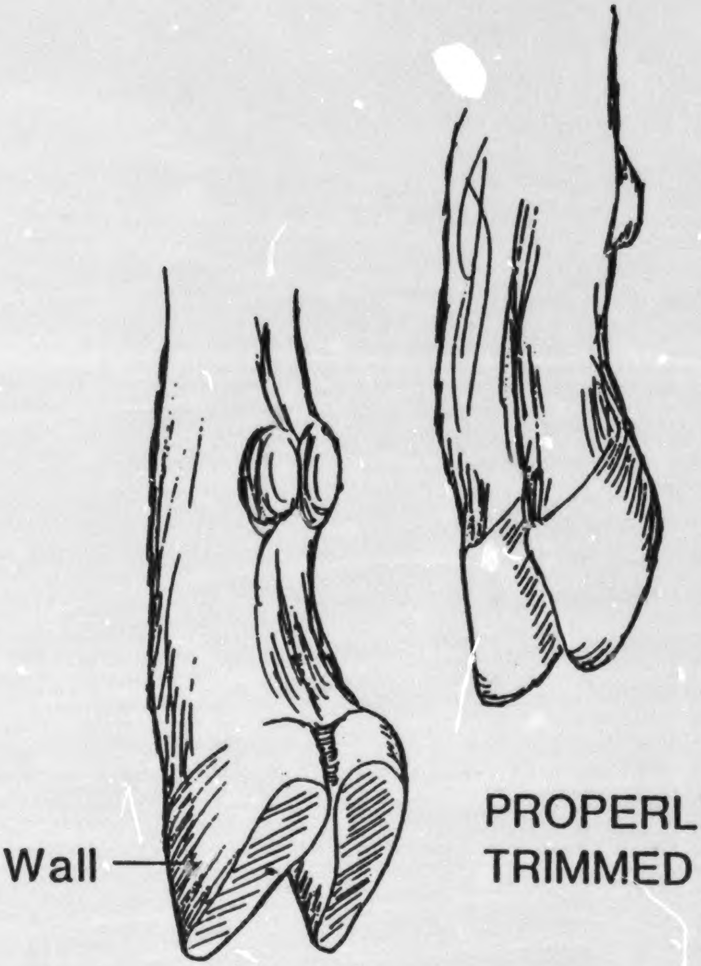
Illustration 5-3

Hoof Trimming



OVERGROWN
Trim to dotted line



PROPERLY
TRIMMED

## Injection Sites

The following abbreviations are for the corresponding type of injection and the site on the goat as shown in the illustrations.

**I.M. (Intro-muscular)** - injected deep within a major muscle mass; for example, deep within the hind leg or in the big muscles on the shoulder. Should be given with a 18 gauge, 1" or 1-1/2" needle pointed straight into the muscle. Before injecting the drug always withdraw on the syringe plunger, to make sure you have not hit a blood vessel.

**S.Q. (Sub Cutaneous)** - injected under base skin on the goat, usually in the two areas shown on the neck and behind the shoulder. Usually a 1/2" to 1" needle is used and inserted at an angle through the skin. Best to pick up the skin with your fingers before inserting the needle and point the needle away from your fingers, so that you do not stick yourself.

**I.V. (Intravenous)** - injected within a vein, usually the jugular or neck vein as outlined on the illustration. This procedure takes some skill and practice; become thoroughly familiar with the method before using. The vein must be blocked with one hand near the shoulder to enlarge the vein and make it visible. Usually a 1-1/2", 18 gauge needle is used for I.V. injections. All I.V. injections should be given slowly, using only products specifically approved for this method. The heart should be closely monitored as heart block may occur.

**I.P. (Intraperitoneal)** - injected in the high flank into the abdomen near the area of the paunch or rumen (large part of stomach). This technique is not commonly used and should be avoided, if possible.

**Intramammary** - injected within the milk gland--into the end of the teat through the natural opening in the end. Always wash the teat end with soap and water and wipe it with alcohol before injections into the gland. Use only blunt teat infusion needles or "throw-away" mastitis medicine applicators--unclean material entering the teat will cause mastitis.

## Disbudding and De-scenting

Goats often fight and removal of kids' horns (disbudding) is very effective in preventing injuries. Horns can be removed easily and safely when the kid is less than 3 weeks old. De-scenting of males also can be done at the same time. This will reduce the amount of unpleasant odor from mature bucks.

To remove horns, you will need a steel pipe (3/4" inside diameter) about 18" long. Put a wooden handle on one end so that you can handle it when it is heated. Then clip the hair from the horn buds and wash and dry the area. The pipe should be heated red hot by whatever means is convenient and the skin around the buds burned as shown in the diagram. The buds should be burned until they can be scraped off--to prevent regrowth.

Removal can be done without anesthesia on very young kids. If anesthesia is desired, consult a veterinarian. Each kid should receive 150 to 200 International Units of tetanus antitoxin (T.A.T.) at the time disbudding is done. Also apply an antibiotic powder to the wound and in areas where screwworms occur, always apply an insecticide or fly repellent.

Illustration 5-4
Injection Sites

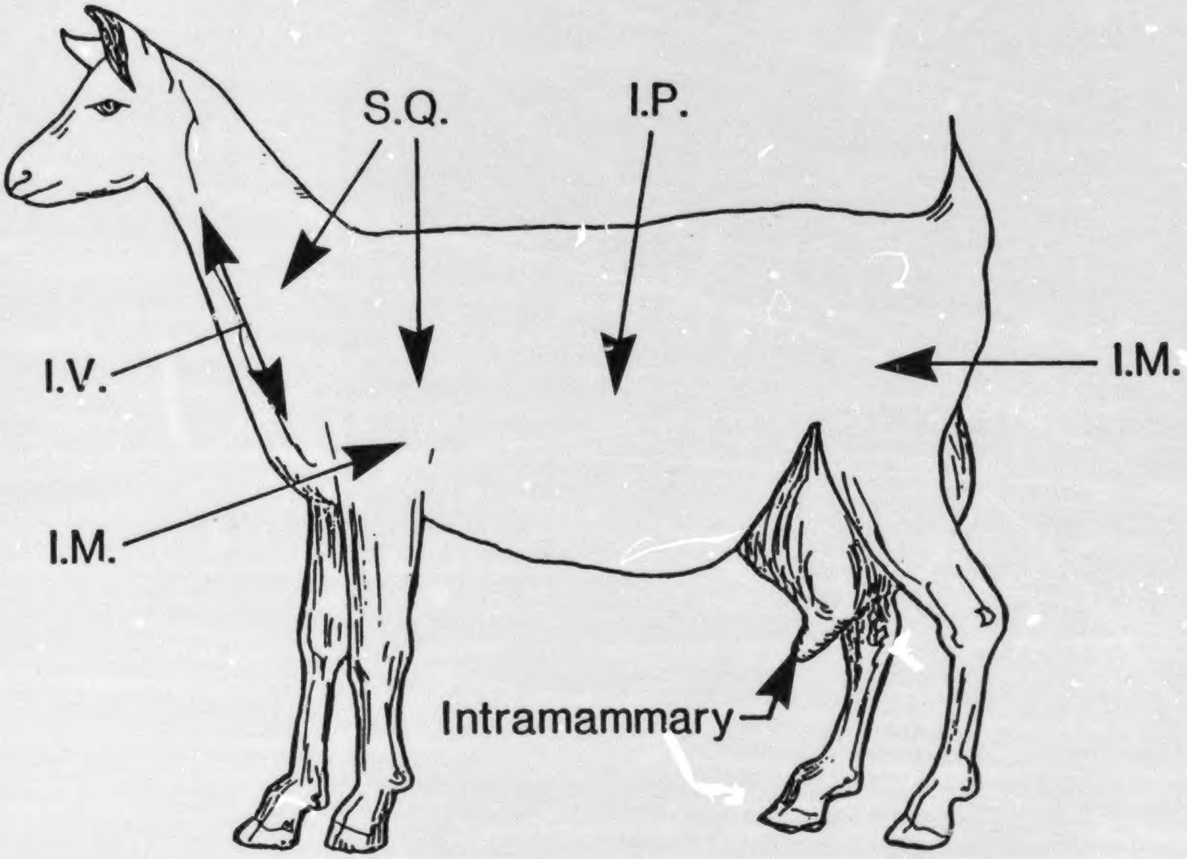
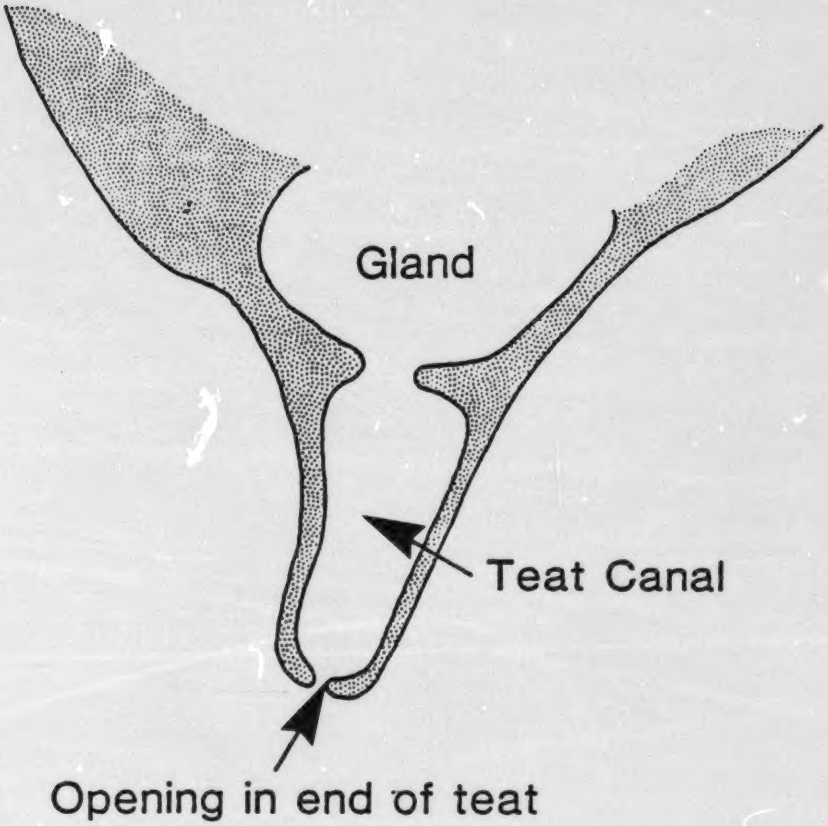
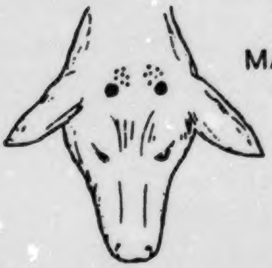

S.Q.
I.P.
I.V.
I.M.
I.M.
Intramammary

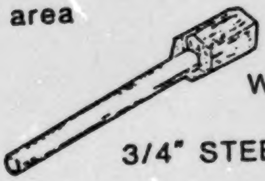
Illustration 5-4
Intramammary

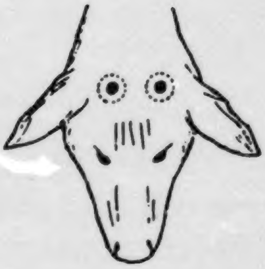

Gland
Teat Canal
Opening in end of teat

### Illustration 5-6

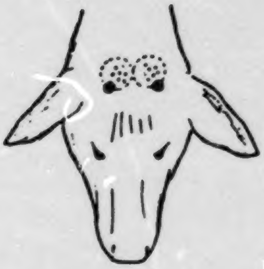
### Disbudding and De-scenting


HORN BUDS
- shaded circles
MALE SCENT GLANDS
- dotted area


WOOD HANDLE
3/4" STEEL PIPE



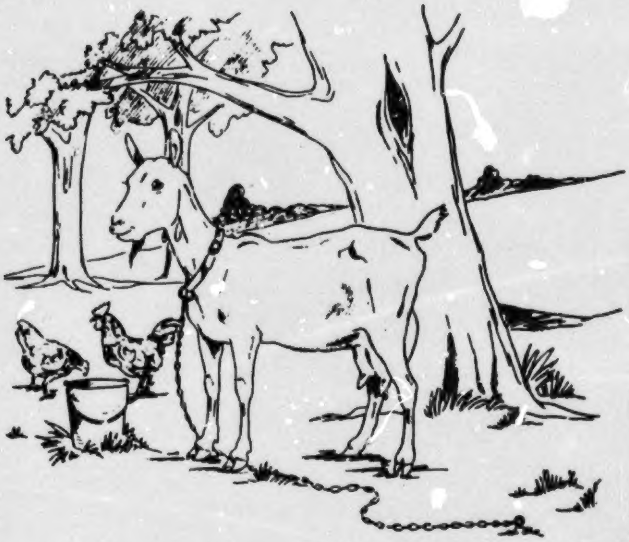
To disbud kids burn an area as shown by dotted circle



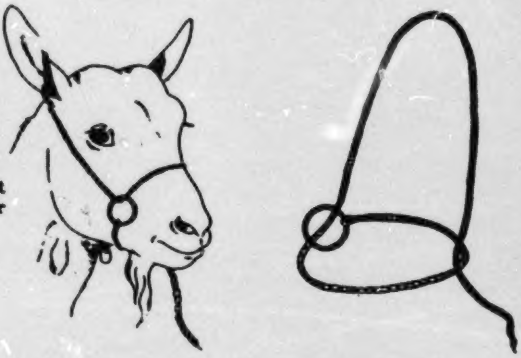
To descent male kids burn a second circle as shown, after disbudding.

## Restraint and Tethering

### Illustration 5-7



**Good tethering practice. Water should be protected against being contaminated by chickens. Goats should be staked far enough from tree to avoid wrapping chain around the tree.**



**A rope halter of this type is very convenient to use about the barn and goat yard.**

The rope halter shown in the above illustration is an inexpensive and easy way of controlling goats. It also provides control of the goat in a way that will not injure the goat. If goats are being raised in your area be sure to check out how local farmers restrain their animals. A simple halter like this can be made from 5 feet of 1/4 inch rope and one metal ring. It is not a good idea to leave a halter on a goat while grazing; they are to be used only while handling the goat.

Tethering may or may not be a practice in your country with goats. It is one way of pasturing goats that assures the farmer that the goat will not wander off or eat forage (such as gardens or crops) that the farmer does not wish to be eaten. However, it also sets the goat up for attack by predators. Furthermore, if the goat is not staked properly, it can become wrapped up in the tether or around a tree. While it is necessary that the goat be allowed access to both shade and water while tethered, be careful not to stake the goat so close that it can wrap itself around the tree. It is a good idea, if possible, to use a chain tether (so the goat can not chew through it) and to place a swivel on both ends of the chain.

## Bloat

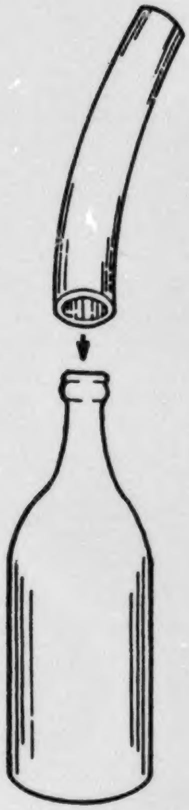
Bloat is caused by cattle and goats eating too much fresh, green, succulent grasses and legumes after being on a diet of dry feed. At the beginning of the rainy season, when the grasses are growing quickly, goats may overeat after being on a maintenance diet during the dry season and bloat. Bloat is an excessive accumulation of gas in the rumen and reticulum resulting in distension. This gas becomes trapped in numerous, tiny bubbles which the goat can not belch away. Bloat is a serious condition which can kill the goat if left untreated, however, proper management should be used to prevent the condition in the first place.

If you see that one of your goats is bloated from too much fresh, green feed, there are two things you can do to treat the condition. The obvious symptoms for bloat are swelling of the entire stomach, particularly on the left side. The animal will be in obvious pain. To treat this: first, elevate the front feet of the goat on a box or block of wood and then use the drench bottle (shown on the opposite page) to force feed a cup of vegetable (palm, peanut, or soybean) oil to the goat. If this treatment does not relieve the condition, then you can try (in extreme cases only) puncturing the stomach to relieve the gas pressure. A sharp, sterile pocket knife can be used to make an incision midway between the last rib and the point of the hip at the peak of the distended flank. A sterile tube or straw should then be inserted into the incision to allow the gas to escape. Treat the wound with a disinfectant and watch the goat for signs of infection. Remember, this is a technique you use only in extreme cases, and you should not try it without supervision of someone who is familiar with the technique if you are not.

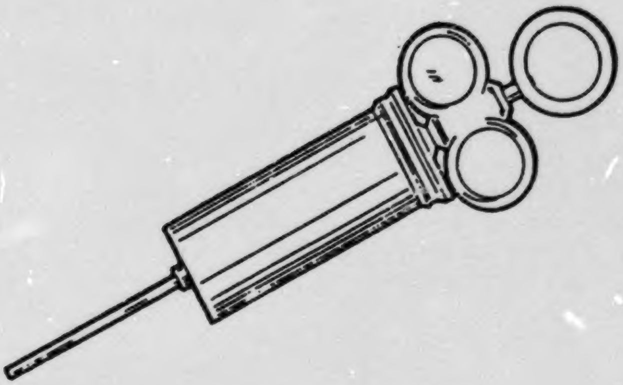
405

## Illustration 5-8

Bottle and Hose and Dose Syringe



Slide hose over bottleneck
to use as a drench bottle



Dose Syringe –
for giving liquid to goats

# REPRODUCTION

## Estrus (heat)

The occurance of estrus for goats of tropical breeds and being reared in the tropics follows different patterns than for temperate breeds being raised in the northern latitudes. In temperate climates, the temperate breeds (Toggenburgs, Saneen, etc.) come into heat in the fall and early winter and then give birth in the spring. Tropical breeds raised in the tropics can enter estrus at any mouth of the year. However, there is some evidence to indicate that different tropical breeds of goats are more prone to kidding during the rainy season when more forage is available. It seems that the most important factor in determining whether a goat is a seasonal breeder or not is the particular breed of the goat, rather than environmental factors.

Estrus occurs in a cycle of 18 to 21 days with the estrus duration being 24 to 36 hours. During this 24 to 36 hour period, the doe will mate with a buck. Ovulation tends to occur towards the end of the "standing heat" period in the doe so it is best to wait at least 12 hours after you detect the doe's heat before breeding her. In order to increase the chance of twins or triplets being born it is good to mate the doe twice. The second mating should occur 24 hours after the first mating. If the doe does not conceive she will return to standing heat in 21 days (this number of days varies depending on the individual doe, her breed, the climate, and her diet). Although it is possible to breed does as early as 4 months of age, it is preferable to let the doe reach 7 or 8 months of age before breeding. This gives the doe time to grow in size and times the kidding with her first birthday. The main reason to wait for the doe to reach 7 or 8 months before breeding is that she will produce healthier kids and be better prepared to produce milk because her age will allow her to withstand the stress better.

## Breeding

Indications of estrus or heat in the doe:

- Milking does will produce less milk.
- Loss of appetite, nervousness, and bleating.
- Swollen genitals and a slight mucuous discharge.

If the doe has these signs, then it is time to place her with a buck. Breeding is quick and requires no assistance from the farmer or you. After breeding, it is a good idea to separate them again. Goats should be mated in the cool of the morning and evening and not during the heat of the day. High temperatures reduce libido and lower fertility rates. In free ranging conditions where you have no control over the goats movements you will not have any control over breeding. Nutrition (the diet of the doe) and the temperature and humidity all affect conception.

## Gestation

Goats have an approximately 150 day gestation. Nutrition is especially critical during gestation and the doe should receive supplemental feed if possible. However, do not overfeed the doe to the point where she is becoming fat because a fat doe will have difficulty freshening. Milking does will eventually go dry as the freshening date approaches. A 12% C.P. supplemental ration is good for the doe.

## Freshening or Kidding

Freshening or kidding is the act of a goat giving birth. The following are indications that the doe is about to kid:

- Reddening and swelling of the vulva
- Enlargement of the udder as milk is being produced
- A vaginal discharge of mucous
- Increased restlessness, bleating

Does will deliver without any assistance from humans 99% of the time. However, there are precautionary steps you can take to protect the health of the doe and the kid(s). They include:

- Provide fresh bedding for the doe and generally clean the pen. Goats left in the pastures to forage may kid alone, which is O.K.
- If the doe is to be penned make sure that she is alone.
- Remove all feed and water from the doe's pen during kidding.
- Make sure that the doe delivers the placenta after the birth.
- Dip the navel cord of the newborn kid in iodine to prevent infections.
- Keep the newborn kids away from cold and drafts.

## Problem Deliveries

Volunteers without previous experience in assisting goats with kidding may find themselves lost when the goat does not have a normal kidding. Do not try to be a veterinarian when complications arise. Try to have someone on hand for the kidding with experience. The procedures listed below require practice and someone with experience.

## Breech Deliveries

A breech delivery can occur when the kid is not in a normal position for birth, or the doe has a small or injured pelvis, or when a kid is very large.

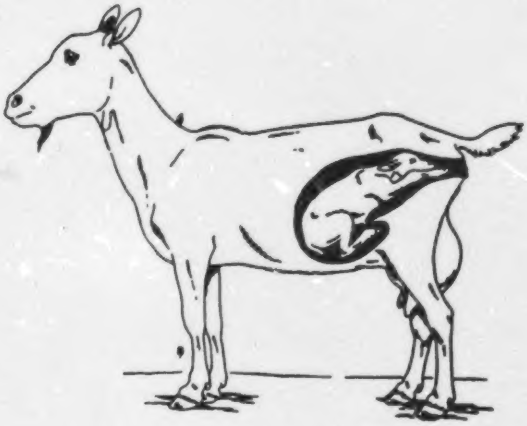
Procedures for a breech delivery:

1. Wash the doe's vulva with warm water and a mild soap.
2. Scrub the hands and forearms as well, with a germicidal soap if possible.
3. Use either a mild soap or mineral oil as a lubricant on your hands and then, very gently, enter the vagina with one hand.
4. Feeling around inside the birth canal try to locate the kid and then move it around so that at least one front leg and the head are in the birth canal, if you can locate both front legs--even better. When the kid is in position, with both front legs and the head in the birth canal, wait for the doe to have a contraction and then with a gentle but firm pull bring the kid on out. You can use a small cord to tie around the front legs to make it easier to pull the kid out. Pull only with your hands and do not use any mechanical devise for leverage because you may injure the doe.
5. When the kid has been delivered, remove the membranes from the nostrils so that the kid can breathe. Remove any excess mucous from the nostrils. Do not attempt mouth to mouth or mouth to nose resuscitation because of the possibility of disease transfer.
6. If the kid is breathing properly, then dip the navel and umbilical cord in iodine to avoid bacterial infection.
7. Leave the kid with the doe for her to lick it and dry it off. Make sure that it can stand alone and that it nurses within 3 to 6 hours. Make sure the kid gets several nursings of colostrum in the first 24 hours. Keep the kid away from the damp and cold.

The illustrations below show a normal presentation for birth and 3 presentations that may produce problem deliveries that require someone to assist the doe by altering the position of the kid.

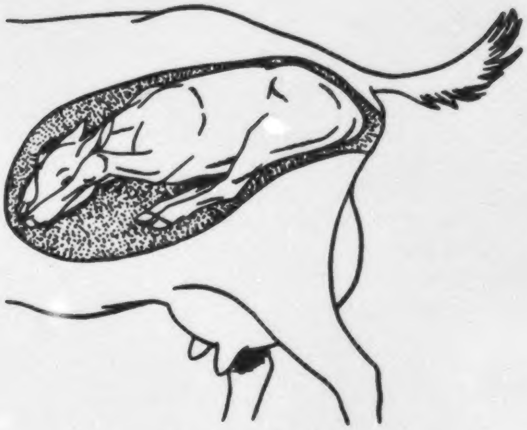
Illustration 5-9

1



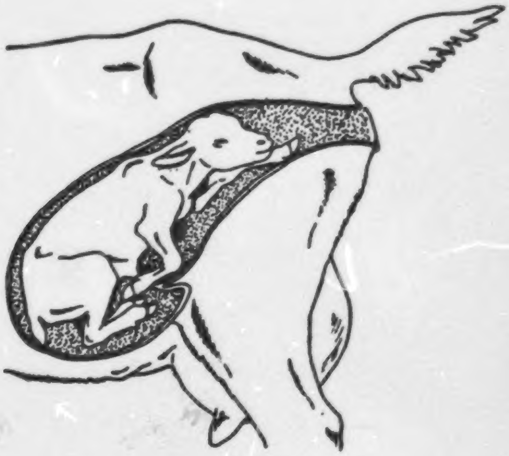
Normal position

2



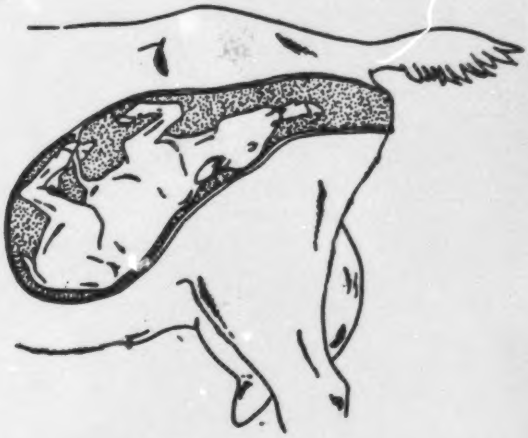
Breech presentation

3



One foreleg back

4



Inverted position

## Lactation

Lactation (milk production) will ocur in almost all does after they freshen. For the farmer raising the goat he has two choices about what to do with the milk. Either he can allow the doe to nurse the kid and use the milk for production of kids (more meat) or the farmer can remove the kid and milk the doe to provide the milk for humans. The farmer's decision on which to do will be based on his reason for having goats. Are the goats being raised at the subsistence level for meat, milk, leather, and/or mohair or is the farmer at a higher level of production and raising goats for milk?

A commonly asked question is: How much milk will a goat produce? The answer is different for every goat. Listed below are some of the factors that a volunteer would need to consider in trying to anticipate milk yield.

-- The quality of the doe's diet.

-- The age of the doe.

-- The breed of the doe.

-- The nutrient value of the browse the doe eats.

-- The management skills of the farmer.

-- The overall health of the doe.

Most does will dry up by the tenth month of milking. Weaning of kids, poor diet, climactic stresses, and rebreeding could all cause the doe to dry up sooner than the 10 months. Because there are no simple answers about the amount of milk a doe will give, how long her lactation will last, or what is the best use of her milk, it is best to work with each individual farmer for a few months in order to assess his or her resources before making any recommendations to the farmer.

Because the various breeds of goats raised in the tropics are small of stature and have been genetically selected by farmers for their survival rather than production characteristics, milk production tends to be quite low. A poor nutritional diet for the doe further reduces the amount of milk she might produce. Goat's milk is easier to digest than cow's milk because the fat globules are smaller in size. The Saneen and Anglo-Nubian breeds from temperate climates are the superior milk producing breeds.

## Weaning

Kids can be weaned at any age from birth up to six months age. Farmers raising meat goats will commonly delay the weaning in order for the kid to gain full nutrient benefit from the doe's milk. In dairy goats however, the kids are removed at birth to be raised on a bottle, or killed, while the doe's milk is used for domestic or commercial purposes.

## Recordkeeping/Field Notebook Guide

As with other animals, it is necessary to keep records on your goats in order to detect nutritional, disease, or management problems; as well as determining profit or loss. A large calendar to record observations and events on the appropriate dates and a simple ledger are all thats needed for adequate recordkeeping in a small scale project. Don't trust your memory to recall important information and dates.

### Record of Expenses

A few basic bookkeeping skills are all that is needed to keep track of all the expenses involved in raising goats. Record the following information in order to be able to determine profit or loss.

-- Cost of feed, medications, vaccines, new breeding stock, supplies, etc.

-- Selling prices for any goats sold, any income or milk sales, stud service fees, etc.

### Production Information

Here you can use a calendar and a notepad to keep good records. These records should include the following points:

-- Breeding, weaning, freshening, and slaughter dates.

-- Dates of any medications given.

-- Observations on the health of the herd.

-- Observations on the pasture or range forage productivity.

-- Records (kept daily) on the amount of milk each doe produces (best kept in pounds).

-- In high production dairies, information on butterfat content is useful.

-- Periodic weight information to determine feed/gain ratios in your meat herd.

-- Seasonal observations on disease or parasite problems.

-- Observations on the health and survivability of each doe's kids.

# APPENDIX A

## LIVESTOCK STAFF
## BIBLIOGRAPHY AND RESOURCE MATERIALS

There are 14 books listed that we are suggesting as references to be used by the livestock staff in preparing for and actually running a livestock training. The first five (5) texts that are listed are valuable to trainers in general, no matter which specific animals are being covered in their particular training. The remaining listings are specific to the animals they are listed under and should be selected based on which animals you are providing training on. We have listed the names of the various publishers for these texts in order to make locating them easier. In a stateside training one could contact a local bookstore or a university library for the needed information on ordering these texts or contact the publisher directly. For in-country trainings it would be best to contact I.C.E. and order these books in advance of training. Ordering a month before training is due to begin is a good idea so that ICE would have the needed lead-time to respond.

1. Feeds & Nutrition - Complete
   by M.E. Ensminger & C.G. Olentine
   The Ensminger Publishing Co.
   3699 E. Sierra Ave
   Clovis, California 93612

   Price: $60 - but well worth the money. Most complete text published on animal nutrition & feeds.

2. The Merck Manual of Veterinary Science
   Fifth Edition - 1979
   Merck & Co., Inc.
   Rahway, N.J.

   Price: $17 to $20
   Best manual available on disease diagnosis.

3. Keeping Livestock Healthy - A Veterinary Guide by N. Bruce Haynes D.V.M - 1978
   Garden Way Publishing
   Charlotte, Vermont

   Price: $10
   A laymans guide to working with animals - simpler language than the Merck manual - good diagrams & illustrations.

4. Improvement of Livestock Production in the Tropics by McDowell

5. Applied Animals Feeding & Nutrition by
   M.H. Jurgens
   Third Edition - 1974
   Kendall/Hunt Publishing Co.
   Dubuque, Iowa

   Easy to read - information is in outline

6. The Nutrient Requirements of Swine, Eighth Edition - 1979
   The Nutrient Requirements of Rabbits, Second Edition - 1977
   The Nutrient Requirements of Poultry, Seventh Edition - 1977
   The Nutrient Requirements of Goats, First Edition - 1981
   Office of Publications
   National Academy of Sciences
   2101 Constitution Ave., NW.
   Washington, D.C. 20418

   Price: $6 - $9 each
   Excellent resource - highly recommended. Contains information of nutrient requirements in different stages of growth & production as well as nutrient feed values.

## POULTRY

| | |
|---|---|
| 7. Poultry Science by M.E. Ensminger 1980<br>The Interstate Printers & Publishers<br>Danville, Illinois<br>Also available through I.C.E. | Complete text on raising all types of birds - not just chickens. An excellent reference. |
| 8. Nutrition of the Chicken by Scott, Nesheim, & Young<br>Second Edition - 1976<br>M.L. Scott & Assoc.<br>Ithaca, N.Y. | Good information on tropical |
| 9. Poultry Production by Card & Nesheim<br>Eleventh Edition - 1972<br>Lea & Febiger<br>Philadelphia, PA. | Good information on nutrition disease. A complete text. |

## GOATS

| | |
|---|---|
| 10. Goat Production in the Tropisc by Devendra & Burns 1970<br>Commonwealth Agricultural Bureaux<br>Farmham, Bucks, England | Excellent text. Provides specifics to goat raising in all tropical zones of the world. Emphasis on meat goats as well. |
| 11. The Role of Sheep & Goats In Agricultural Development 1976<br>Winrock International Center<br>Morrilton, Arkansas | Good technical resource. |
| 12. Dairy Goats - Breeding/Feeding/Management<br>American Dairy Goat Assoc.<br>Box 186<br>Spindale, N.C. 28160 | Price: $2 each<br>More specific to dairy than goats. Good introduction but lacks detail. |

## SWINE

| | |
|---|---|
| 13. Swine Science by M.E. Ensminger<br>Fourth Edition - 1970<br>The Interstate Printers<br>Danville, Illinois | Most complete text on swine production that I have seen. Written, however, for U.S. producers of swine. |

## RABBITS

| | |
|---|---|
| 14. Rabbit Production<br>O.S.U. Rabbit Research Center<br>Oregon State University<br>Corvallis, Oregon | New text - just published. Quite complete.<br>Price: $12 |

## Livestock publications to be distributed to the trainees:

The publications listed below are recommended to supplement the written guideline material already contained in the livestock training manual. Information is included concerning the contents & value of the text as well as where it can be obtained.

RABBITS

* 1. Raising Rabbits by Harlan D. Attfield
VITA Inc. 1977
3706 Rhode Island Ave.
Mt. Rainier, Maryland 20822

It is critical that this text be distributed to trainees receiving rabbit training. Our guidelines were written to complement this book and are quite incomplete without it. Price: $4 from VITA, but available free from P.C. I.C.E.

2. Raising Rabbits - The Modern Way - by
Bob Bennett 1975
Garden Way Publishing
Charlotte, Vermont 05445

Price: $5. Less valuable than the Vita text. Geared to production in the States.

POULTRY

* 3. Practical Poultry Raising by Ken French
ICE Manual #M11.
Available through P.C. I.C.E.

It is critical that this text be distributed to trainees receiving training. Our guidelines were written to complement this text and are quite incomplete without it.

4. New Methods Pay with Poultry by McArdle
and Panda
ICE Manual #R30.

Written primarily for India. A good reference text but less valuable than Practical Poultry Raising.

5. Salsbury Manual of Poultry Diseases
Available through I.C.E. or:
Salsbury Laborotories
Charles City, Iowa 50616

Price: Free from ICE or $2 each from Salsbury. An excellent tool in disease diagnosis, prevention, & treatment. Many color plates & pictures of diseased birds.

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* As noted above these two (2) books directly complement our guidelines and must be included or the training technical package will be incomplete. It is best to order these books one month before the beginning of training.

### SWINE

6. Small-Scale Pig Raising by Dirk Van Loon 1978
Available through ICE or through
Garden Way Publishing
Charlotte, Vermont

Price: $6 from Garden Way
Good diagrams and pictures. A good complement to our guidelines.

### GOATS

7. Dairy Goats - Breeding/Feeding/Management by Byron Colby
American Dairy Goat Assoc.
Box 186
Spindale, N.C. 28160

8. Aids to Goatkeeping by Carl A. Leach
Eighth Edition 1974, also available through I.C.E.
Tiger Press
Columbia, Missouri 65201

9. Raising Milk Goats - The Modern Way by Jerry Belanger
Garden Way Publishing 1975
Charlotte, Vermont

All three (3) of these books are good general information sources. However, all of them were written for production work in the United States and none contain detailed information on working with goats in the tropics or Third World countries.

## APPENDIX B

## LIST OF SUPPLIES

Physical shelter is needed for the animals, either a large barn or large huts. This is needed to house all the animals to be used in the training and should be in place prior to training. Construction work should be made to include cages, pens, stalls, milking platforms, stanchions, mangers, waterers, feeders, nesting boxes, brooders, and farrowing crates. The animals should be on hand and housed when the trainees arrive (except the day old chicks).

### General Materials for Livestock Training:

- Pigs, chickens, ducks, goats, & rabbits
- Various animals feeds
- Rope, buckets, and fencing
- Lumber (2x4s, plywood, etc.)
- Buck knife and stone
- Hammers, saws, square, and level
- Nails, pliers, and watering can
- Floor litter (straw or sawdust)
- Kerosene lamp and kerosene
- Feed scales, feed scoops
- Feed storage drums
- Shovel, pitchfork, & broom
- Water hose, wire, & chickenwire
- Thermometer & Anal Thermometer
- Scissors

### Veterinary Kit Materials

- Tetracycline
- Penicillin
- Streptomycin
- Injectable vitamins
- Malathion (5% WP & 50% liquid)
- Wound spray
- Razor blades
- Oxytocin
- Iodine
- Toe nail clippers
- Combiotic
- Syringes
- 18 & 20 gauge needles
- Disinfectant (topical)
- Sprayer or watering can
- Alcohol
- Thread and needles
- Deworming medicine (Atgard or Piperazine)
- Injectable iron
- Indelible ink
- Coccidiostat
- Vegetable oil
- Fowl Pox vaccine (with applicator)
- Newcastle vaccine

### Ruminants - Goats

- Hay or grass
- Pasture
- Mixed feeds 16% CP (dairy)
- Salt block
- Feed ingredients (samples on bulk)
- Deworming boluses
- Mastitis test kits
- Mastitis treatment
- Halters
- Tethering chain and snap hooks

# APPENDIX C

## SMALL ANIMAL PRODUCTION
## TRAINING GOALS

A. General Livestock Development

Trainees will;

1. List the 5 components of livestock development.
2. List 5 examples (1 from each of the 5 components) that make an operation to be:
   - a. Low Production
   - b. Moderate Production
   - c. High Production
3. Evaluate 3 livestock operations to determine the level of production and make management recommendations based on local conditions and resources.
4. Participate in all scheduled farm visits.
5. Describe the major climactic zone, rainfall and cropping patterns, infrastructure, planting and harvest dates of forages crops, and common management practices for animals in your host country.
6. Learn how to mix protein concentrates with energy feeds by using the Pearson square method and will hand mix at least one feed ration.
7. Maintain a field notebook.
8. Keep feed consumption records for each animal used in training.
9. Understand the causes, transmission, prevention, and treatment for animal diseases.
10. Learn the basic concepts of animal nutrition and develop a clear understanding of their own nutritional needs as well as those of the people they will be working with.
11. Learn how to use the Farmer Livestock Survey as a tool in determining the production levels of different animals in their respective villages.

B. Swine Production

Trainees will;

1. Feed and care for an about to farrow sow and a litter of weaned feeder pigs during training on a daily rotating basis.
2. Balance one swine feed ration.
3. Participate in a slaughter, field dressing, and post mortem session.
4. Construct feeding troughs, waterers, and a farrowing crate.
5. Contrast traditional and improved methods of swine raising and discuss their pros and cons in terms of cost returns.
6. Give feasible production goals for the small scale farmer.
7. Describe the reproductive period of the sow as to: estrus, gestation, heat symptoms, lactation, signs of farrowing, and post weaning heat.
8. Assist a sow during farrowing.
9. Give guidelines for and perform the following techniques; clipping of needle teeth, tail docking, iron shots, and castration of new born piglets.
10. Distinguish between sick and healthy pigs.
11. Disinfect one hog shed and list one readily available disinfectant in your host country.
12. Discuss the nutritional requirements of pigs and balance 1 feed ration.
13. Treat for 2 common internal parasites and discuss their prevention, diagnosis, and treatment.
14. Treat for 2 common external parasites using a recommended insecticide for their control.
15. List 3 major swine diseases, discuss their symptoms, prevention, and treatment.
16. Design a management plan and operation schedule for a 2 sow operation. Include inputs, costs, and estimated returns.
17. Administer medications and deworming medicines as required.
18. Keep production records on the training swine project and use them to determine profit or loss and the level of production.
19. Describe swine anatomy in relation to animal production. Give guidelines on swine selection and discuss methods of herd improvement feasible for small scale farmers.

C. Rabbit Production

Trainees will;

1. Feed, water, and care for at least 3 about-to-kindle does during training on a rotating daily basis.

2. Observe the mating of one pair of rabbits.

3. Feed, water, and care for a group of weaned fryers and 1 or 2 bucks.

4. Give feasible production goals for small rabbit raising and the pros and cons of rabbit production.

5. Distinguish between sick and healthy rabbits.

6. Determine pregnancy in a doe by palpation; accurately determine the sex of rabbits over 8 weeks of age, and hold a rabbit correctly.

7. Participate in the construction of cages, feeders, and waterers.

8. Balance on feed ration for rabbits.

9. Describe the reproductive cycle of rabbits.

10. Diagnose ear mites and apply the necessary treatment. Treat also for mange and conjunctivitis.

11. Treat for coccidiosis, describe the symptoms, and give the methods of control. List 4 management guidelines for minimizing the disease.

12. Participate in the slaughter, field dress, and post mortem exercise.

13. Ear tatoo at least one rabbit.

14. Learn how to keep production and breeding records. Keep a field notebook.

15. Determine the feed to gain ratio for the rabbits in the training project and do a cost/analysis of the projects based on local market conditions.

16. Keep precise feed consumption records for the training rabbit project.

D. Poultry Production

Trainees will;

1. Brood, feed, and care for a batch of 50 day old chicks on a rotating basis throughout training.

2. Feed, water, and care for all other poultry used during training.

3. Contrast improved and traditional poultry raising practices and discuss their pros and cons.

4. Give broiler and layer production goals feasible for the small scale farmer.

5. Compare the major pros and cons of cage vs. floor housing under local conditions.

6. Give temperature guidelines for brooding and 3 methods suitable for the small scale farmer.

7. Distinguish between sick and healthy birds.

8. Participate in the construction of waterers, feeders, brooders, and shelter.

9. Vaccinate the flock for Newcastle, Fowl Pox, and Bronchitis.

10. Define coccidiosis, describe the symptoms, and list 2 control measures.

11. Handle and cull laying hens to separate good layers from poor layers.

12. Calculate their own poultry feed ration.

13. Plan and evaluate small scale broiler/egg laying projects at the training site.

14. Participate in a slaughter/dressing/postmortem exercise.

15. Care for and use broody hens to hatch eggs naturally.

16. Treat for parasites.

17. Compare the advantages and disadvantages of raising both ducks and guinea fowl to chickens.

## E. Goat Production

Trainees will;

1. Feed, water, and care for the goats daily on a rotating basis.
2. Describe major parts of the anatomy of a goat and explain the function of each.
3. Describe the reproductive cycle of the goat including sexual maturity, estrus, signs of estrus, breeding day, breeding season, lactation length, and gestation.
4. List 3 signs of the approach of kidding and give 3 recommended practices to be done at and after kidding.
5. Balance 1 feed ration from locally available feeds for medium and high production level goat operations.
6. Identify 3 vitamin and nutrient deficiencies in goats and give recommendations as to how to correct and prevent them.
7. Examine a goat for possible symptoms of disease.
8. Castrate one male goat.
9. Give 1 intramuscular and one subcutaneous injection.
10. Trim the hooves of goats.
11. Make a simple rope halter and tether for leading and restraining.
12. Administer worming medications and coccidiosis control medications.
13. Recommend, prepare, and administer proper doses of antibiotics.
14. Distinguish between a sick and a healthy goat.
15. Identify and treat 3 major diseases of goats. List the causal agent, symptoms, and control measures for each.
16. Milk a doe by hand and keep milk weight records throughout the training.
17. Evaluate a proposed project considering such factors as infrastructure, marketing, site, culture, price of available feeds, water supply, technical support, and short and long term impact.

# APPENDIX D

## SAMPLE EXAMINATION

### Rabbit Questions

1. You have just completed the first year in Luebo. You have a rabbit project just starting with 3 New Zealand does and 1 New Zealand buck. The rainy season has returned and the grazing area of grasses is beginning to grow. You believe that you have no major disease problems in the area and you do have good wire cages to use. It is your plan to make the project labor intensive and utilize the labor of the local school kids. You have arranged to purchase on credit 2,000 lbs. of corn and 400 lbs. of winged beans from a local cooperative. The corn costs 10¢ per lb. and the winged beans 20¢ per lb. You also have access to vitamin and mineral supplement and an adequate supply of limestone.

   A. Based on this information prepare a feed ration for your rabbits.

   B. What is the cost of the ration per pound?

   C. What management problems (only two) do you foresee based on the information?

   D. What feed/grain ration can you expect?

   E. How many fryers will you be able to market with this volume of feed? State your reasoning? How many months will it take to produce your market number of fryers?

   F. What price per pound must your rabbits sell for to realize a reasonable profit?

In the village of Tulume lives Bukasa, a farmer with whom you have established a successful rabbit project. The combination of your expertise and his labor has created an operation with a high investment feed ration, good wire floor cages, no disease problems, and sound management practices. Having accomplished all of this in 12 months, you take an overdue vacation and visit Dar Es Salaam. Upon your return you discover that in your absence Bukasa had a severe case of the flu and was unable to attend to the animals for 2 weeks. During this time two week old rabbits received practically no care, became highly stressed, a severe diarrhea outbreak occured which you diagnose as coccidiosis. In your presence the animals have recovered, but now Bukasa wants to sell all of the animals and replace them with new stock. Do you agree with his decision to sell? Yes/No, if no, give a better option. If yes, give supporting arguments.

# Swine Questions

After a year of working in your village you have become good friends with the farmer Boon Santawong. During several drinking sessions with Boon you have discovered that he raises a few pigs at his home. He asks you how he can get more money for his pigs. Given the following information what would you tell him?

He has two sows and one boar of native exotic cross.

The animals are fed table scraps. During the day they are allowed to forage in a forested area and get water from several mudholes nearby.

Brucellosis is endemic in the region but there has been no recent outbreak. Roundworms, lice, and mites are common. Hog Cholera can be a problem in the hot season.

He raises three crops: Rice for family use as well as for sale, with bran going for 25¢/kilo. Winged beans sell for 50¢/kilo. Cassava is there for the taking as he is too far from any major buyer.

As he sells porks in a sub-district market he must slaughter the animals before sale and loses 30% of the carcass weight. Porks sells for $2/kilo.

It costs him $3 to travel to and from the market with the carcass.

Boon has about $100 per year invest in the pigs.

Bamboo costs $2/7 meter pole (it can be split infinitely according to need).

Lumber costs 50¢/foot (2 by 4).

Sheet metal $5/3 by 6 foot piece.

Straw and coconut are available.

Atgard costs $2/dose.

Malathion costs $5/liter.

Cholera vaccine costs $3/dose.

## Goat Questions

1. A subsistence farmer raises some corn, cassava, and potatoes. He has 5 does, 5 bucks, and 3 kids (as in baby goats!). He gets meat from his goats. He lets them graze freely all day on poor pasture during the dry season. In the rainy season, this pasture becomes moderate (6%CP). (The rainy season lasts about 3 months). At night, the farmer brings the goats indoors for protection. The older goats do not appear to be gaining weight. The younger goats are thin, are coughing, and have rough haircoats. The farmer tells you that he's noticed that there have been fewer kids this past season than normal. He wants to know how to better his situation.

   A. What level of production is he at? Why?

   B. What are the problems you see in the above situation? Use situation, genetics, diseases, parasites, housing, and management as your guidelines.

   C. What level do you think the farmer can achieve? Why?

   D. What recommendations would you make to him? Justify each one.

# Poultry Questions

A. Define and describe the purpose of the following organs of the chicken. Crops, Gizzard, Small and Large Intestine. Although you do not have the capability to diagnose, how can a post mortem on a chicken be used as a credibility technique in the field?

## DUCKS/GUINEAS

Name a breed of chickens and/or ducks that would be ideal for each of the following functions. A. Egg production; B. Meat production; C. Natural incubation. Explain why these breeds are ideal for these functions.

Discuss the advantaged and disadvantages in raising guinea fowl over chickens. How could you solve some of the problems in raising them.

Livestock Questions

1. List and use the five components of animal raising, and explain what advantages does a native breed have over an exotic breed in a low management situation. Why would it be inappropriate to have a native breed in a high or moderate management situation?

2. Provide a brief description of a rabbit cage (materials, design, etc.) for a survival production project, one for a moderate production project, and one geared for Zaire.

3. List the five nutrient needs of animals and explain their purpose. You may use the "construction of the animal" analogy, if you wish.

4. What is meant by "high quality protein"? Give an example of such a protein. Is high quality protein required by goats? Why?

5. What is meant by complimentary proteins? Give an example of two ingredients and their amino acids which complement each other.

6. Explain why some feeds are mixed, chopped, ground, cracked, or cooked before being given to aniamls.

7. Give the general nutrient characteristics of roughages and concentrates.